Be patient

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Be Patient:

A longitudinal Study

On Adoption And Diffusion

Of Information Technology Innovation

In Dutch Healthcare

Ronald Spanjers

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Of Information Technology Innovation

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Ronald Wilhelmus Lambertus Spanjers,

geboren op 9 april 1969 te Eindhoven

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Biography

Ronald Spanjers started his career in 1992 at the financial department of the Jeroen Bosch Hospital in 's-Hertogenbosch (www.jeroenboschziekenhuis.nl). After that he was Manager of the Division Perinatology and Gynaecology at the University Medical Centre in Utrecht (www.umcutrecht.nl), and head of finance and information technology in the Catharina Hospital (www.catharina-ziekenhuis.nl) in Eindhoven. He currently is director of finance and information at the Medical Spectrum Twente in Enschede (www.mst.nl).

Previous work from the author addressed healthcare networked organisations (Peterson, Smits and Spanjers 2000, Peterson, Smits and Spanjers 2001a, Peterson, Smits and Spanjers 2001b, Spanjers, Hasselbring, Peterson and Smits 2001), and information technology stakeholders (Hasselbring, Peterson, Smits and Spanjers 2000, Van de Walle, Spanjers and De Wit 2006), and economic analysis of IT (Spanjers 2007) in hospitals in the Netherlands.

Further, the author's interest in adoption and diffusion of applications of IT innovations has led to disseminated studies on e-learning (Rutkowski and Spanjers 2007, Spanjers and Rutkowski 2005a, Spanjers and Rutkowski 2005b, Spanjers, Rutkowski and Martens 2004), as well as on virtual baby visit systems (VBVS) in the Netherlands (Rutkowski, Spanjers and Genuchten Van 2006, Spanjers and Feuth 2002a, Spanjers and Feuth 2002b, Spanjers and Rutkowski 2003, Spanjers and Rutkowski 2007, Spanjers, Rutkowski and Genuchten Van 2007).

Abstract

Healthcare spending is increasing, and with 9% of the Gross Domestic Product (GDP), has become a factor of economic and political importance in Europe. Healthcare organisations have to modify their business to remain competitive. The author has the vision that information technology (IT) innovations have the potential to revolutionise healthcare and to contribute to its future sustainability.

The emerging field in the intersection of medical informatics, public health, and business, referring to healthcare services and information delivered or enhanced through the Internet and related technologies, became known under the term 'e-health'. The World Health Organisation (2006) proposed a compact definition of e-health: "the use of information and communication technologies for health". Even with its potential to lower costs and transform healthcare; economy, policy and technology barriers seem to hinder the adoption and diffusion of IT innovations.

One of the challenges in adoption and diffusion research is to study innovations that contribute to the public good, but diffuse slowly. This research generates insight into the adoption and diffusion of an IT innovation in healthcare presented in a longitudinal case study and market analysis in hospitals in the Netherlands. The IT innovation, Virtual Baby Visit System (VBVS), is an Internet based facility providing a live video stream that connects parents to their hospitalised new-born. The case study is analysed along the stages of the innovation-decision process: the first knowledge (initiation) of an innovation, towards forming an attitude toward the innovation, the decision to adopt or reject, the implementation of the innovation, and the confirmation of the decision.

An in-depth investigation of the adoption and diffusion of IT innovation with a focus group of IT management in hospitals demonstrates that financial resources, alignment and perceived IT innovativeness do not play a significant role the adoption and diffusion of IT innovations such as the VBVS. A positive relation is suggested between perceived personal IT innovativeness and the adoption and diffusion of IT innovations such as the VBVS.

This research combines 10 years of research with 20 years of field experience, with contributions of over 150 participants from healthcare, from IT managers to patients. Three factors played an important role in the IT innovation alignment for the VBVS: economy, policy and technology. The results of this research lead to the following conclusions:

Economy - The VBVS in the Netherlands represent an potential economic value of 1.9 million Euro; less than 0.7% of the average hospital annual budget for IT and almost 0.002% of the average hospital annual budget. The relative negligible economic effect of this investment far outweighs the intangible effects in the innovation-decision process. Support of the policy, high promotional value, and identification with the innovation are examples of these intangible effects that supported the adoption and diffusion of the VBVS technology.

Policy - New and unfamiliar technologies can generate ethical concerns, and issues such as trust and confidence, that must be addressed. Hospital policy and legislation in the Netherlands was not a barrier in the adoption and diffusion of the VBVS.

A key element in the adoption of the VBVS is the policy commitment of the perinatal centres to provide family centred care, in a healing environment; supporting the development of the new-born beyond the boundaries of the hospital. This policy stimulated the healthcare professionals in the adoption and diffusion of the VBVS technology.

Technology - Over time the technology evolved and supported the sustainability of VBVS. The increasing quality and availability of bandwidth supported higher image quality and accessibility, stimulating the VBVS through the phases of adoption and diffusion.

Patient - IT management played a crucial role in the IT alignment process of the VBVS, their patient centred approach was favourable in the decision-making process, stimulating the nationwide adoption and diffusion of the VBVS.

However, IT management in healthcare organisations still has an internal focus when it comes to IT innovations; at best, healthcare professionals are treated as customers, instead of the patients. When IT management realises that the actual adoption and diffusion of an IT innovation in healthcare is an expression of the intangible benefit it brings the patients...

... IT management can consider stimulating the adoption and diffusion of IT innovations by aligning the decision making process around the patients' needs, and literally 'be patient.'

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CHAPTER 1

Introduction

"When I look at where we stand and where we are supposed to be, I find it rather depressing. Because I find that the introduction of things, which in fact, should be standard facilities, is very time-consuming (...) This has nothing to do with innovation; it concerns products and processes that have been around for years. There is no room for real innovation, because you're simply behind with things you already wanted to have done."

Head of IT and innovation, top-clinical hospital (subject 2)

Healthcare spending is increasing, and with 9% of the Gross Domestic Product (GDP) has become a factor of economic and political importance in Europe. Healthcare organisations have to modify their business to remain competitive. New technologies have the potential to revolutionise healthcare and contribute to its sustainability.

IT innovations introduce new channels of communication to deliver or enhance health services. Why are these IT innovations successfully used outside healthcare, and seem to take forever to take effect in healthcare organisations? Could this be due to the lack of financial and IT resources? Could it even be the inappropriateness of a specific IT in the healthcare environment? Is the adoption and diffusion of IT innovations led by luck and coincidence rather than by management? These questions motivate delving deeper to find solutions.

1.1. Growing cost of healthcare, and IT in healthcare

This section addresses the context healthcare and the potential of IT to increase productivity in healthcare.

In *Together for Health: A Strategic Approach for the EU 2008-2013* the European Community (European Community 2004) sets the goals for e-health in Europe: improve prevention of illness and delivery of treatments; reduce the cost of errors, fraud and duplication in process; support a shift from hospital care to prevention and primary care; and help in providing better patient-centred care and support interoperability across national boundaries.

As is presented in Figure 1, in European countries the average healthcare spending per capita has a wide range; for example USD 618 for Turkey versus USD 3,800 for the Netherlands. Also, average life expectancy at birth has a wide range from 73 years in Turkey to 80 years in the Netherlands.

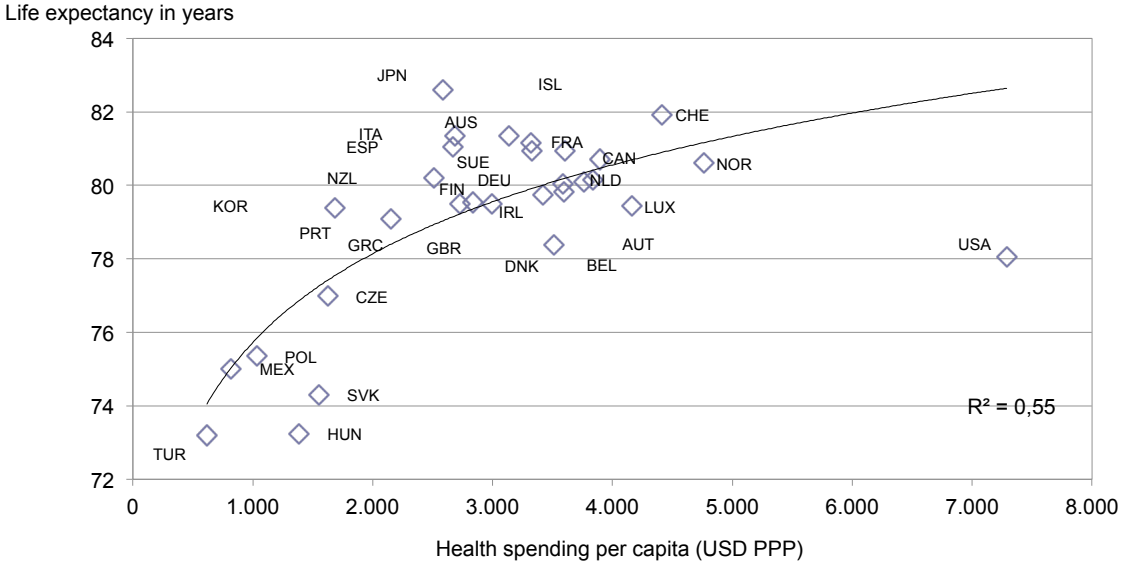


Figure 1: Per capita healthcare spending (USD PPP) versus Life expectancy in years

In general, higher life expectancy (and lower birth rates) has had a rising effect on the healthcare spending per capita and vice versa. As presented in Figure 2 the Organisation for Economic Cooperation and Development (OECD) reports the average life expectancy at birth increased by almost 10 years in the years from 1960 to 2007.

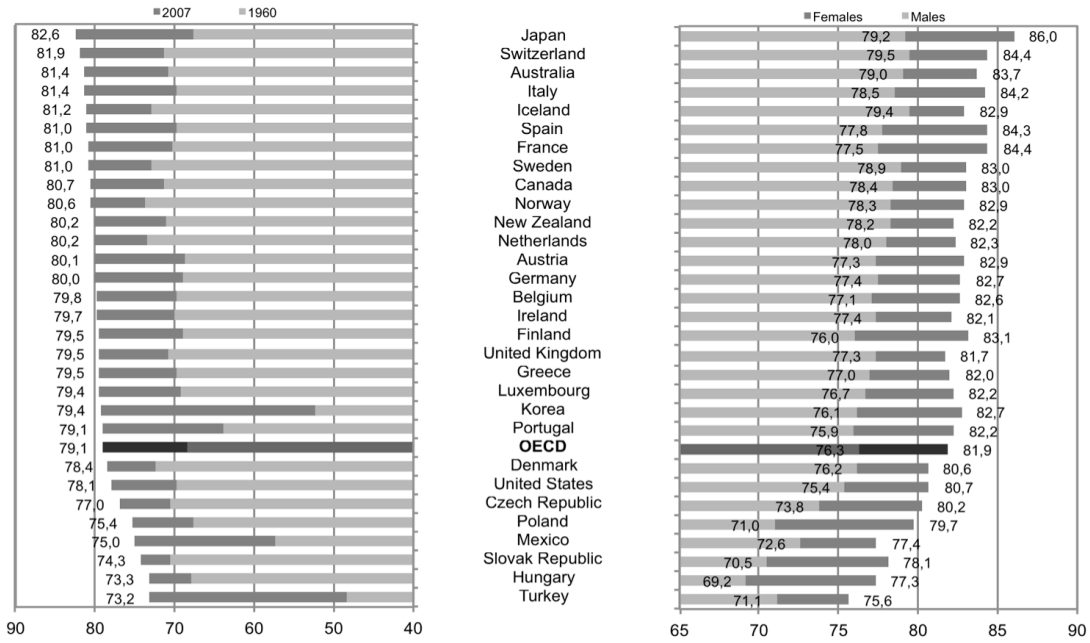


Figure 2: Left; Life expectancy at birth OECD in years, total population, 1960 and 2007, Right; Life expectancy at birth 2007 in years, by gender.

The future growth of healthcare spending also depends on factors such as country policies towards health economics, cultural and ethical factors, and new technologies. Gross domestic product (GDP) is an economic indicator of the market value of all final goods and services produced in a country in a given period. GDP per capita is often considered an indicator of a country's standard of living.

Annual growth rates of total healthcare spending adjusted for inflation from 1997 to 2003 ranged between 2 to 5% (Anderson, Frogner, Johns and Reinhardt 2006) for most European countries, with these countries spending an average of 9% (OECD, 2007) of their GDP on healthcare. During this period Europe's GDP was 10,000 billion Euro. With a population of 750 million, the average annual healthcare spending per capita was 2,600 Euro. With an employment rate of 60%, (450 million) 1 out of 10, roughly 45 million or more Europeans worked in healthcare service related jobs. Thus, as this quick calculation shows, healthcare is an economic factor of importance, and therefore small improvements in productivity may yield a large effect.

In 1995 the Wall Street Journal (Anders 1995) reported that health care organisations were reducing costs by redesigning work so that tasks once done by high-cost personnel were then done by lower cost personnel. This is still generally true today. Physician extenders, such as physician assistants and nurse practitioners, now deliver healthcare previously delivered by physicians (Abbott and Coenen 2008, Anders 1995, Dierick, van Daele, Steuten, Romeijn, Derckx and Vrijhoef 2011). Healthcare, previously carried out by licensed and registered nurses, is now done by nursing aides, while nurses take on the role of managing a team of caregivers. This trend that is typical of a re-engineering movement in hospital management is known as patient-centred care, as opposed to department-centred care.

Hospitals have to modify their business model to maintain and enhance their competitive position in the market toward a patient-centred health care culture. Patients' increasing awareness on their medical status and related growing demand for transparency on medical results make healthcare a strong competitive market (Landro 2009, Schaefer Munoz 2004).

The driving forces in this market are: competition within healthcare, newly developed healthcare technology, and 21st-century health-care consumers with their expectations of free choice and a high level of healthcare (Lievens and Jordanova 2004).

European Union health systems are under mounting pressure to respond to the challenges of population ageing, patients' rising expectations, migration, and mobility of patients and health professionals. The European Union expects that IT innovations have the potential to revolutionise healthcare and health systems and to contribute to their future sustainability. To support the goal "Smart growth – an economy based on knowledge and innovation" one of the European Union flagship initiatives is *A Digital Agenda for Europe* (2010a). Member States will need to promote deployment and usage of modern accessible online healthcare. In *Together for Health: A Strategic Approach for the EU 2008-2013* (2007) the European Union aims to support dynamic health systems and IT innovations.

IT innovations in healthcare may have the potential (Atienza, Hesse, Baker, Abrams, Rimer, Croyle and Volckmann 2007, Heeks, Mundy and Salazar 1999) for introducing low-cost, high-efficiency components that may, under certain conditions, increase access to care while possibly limiting increases in cost, by enhancing health outcomes (McDonald 1995).

The potential of IT to increase productivity in healthcare is high. The European Community, with a GPD of 10,000 billion Euro, annually spends 900 billion Euro (9%) on healthcare. At an estimated 3% cost of IT, Europe spends around 27 billion Euro annually on IT. Let us assume that a 10% structural increase of IT investments (a ball-park figure) in e-health will create a 1% structural increase in productivity (or cost reduction).

This means a structural increase in IT cost of 2.7 billion Euro (or a 27 billion Euro initial investment depreciated in 10 years), generates 9 billion Euro of structural cost reduction, a net saving of 7.2 billion Euro annually in Europe. On the level of a hospital with an annual budget of 300 million Euro, the net savings of such an investment could be 2.4 million Euro annually (Spanjers 2007).

Since the release of the reports *To Err is Human* and *Crossing the Quality Chasm* (Institute of Medicine Committee on Quality of Health Care in America 2001), health IT innovations have been recognized as essential components for an improved health system.

In *To Err is Human* Kohn, Corrigan and Donaldson (1999) claimed that health care in the United States was not as safe as it could be expected to be:

"At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year as a result of medical errors that could have been prevented. Even using the lower estimate, preventable medical errors in hospitals exceed amendable deaths to such feared threats as motor-vehicle wrecks, breast cancer, and HIV. One oft-cited problem arises from the decentralized and fragmented nature of the healthcare service system or "non-system," to some observers. When patients see multiple providers in different settings, none of whom has access to complete information, it becomes easier for things to go wrong".

Although progress since then has been slow, the IOM report truly changed the conversation to a focus on changing systems, stimulated a broad array of stakeholders to engage in patient safety, and motivated hospitals to adopt IT innovations such as electronic health records (Leape and Berwick 2005).

In addition to the economic potential that IT can offer healthcare, there is the quality aspect to the adoption and diffusion of IT innovations (Damberg, Ridgely, Shaw, Meili, Sorbero, Bradley and Farley 2009). The adoption and diffusion of IT innovations should be done with great care, when the electronic health record is widely introduced the risk of errors in that electronic communication can increase. For example: the research by Nebeker, Hoffman, Weir, Bennett, and Hurdle (2005) reports that high rates of adverse drug events (errors) in a highly computerized hospital may continue to occur after implementation of a computerized physician order entry system and related computerized medication systems that lack decision support for drug selection, dosing, and monitoring.

IT innovations in healthcare can be defined from a multi-level perspective (Nijland 2011). Eysenbach (2001) has defined this emerging field on the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related IT innovations as "a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology."

Traditionally, IT in healthcare has mainly served patients indirectly by supporting medical staff within the walls of the hospitals. More recently, electronic patient records, e-mails, phones and pagers have been used to facilitate communication to co-ordinate medical actions and to improve patients' care inside the hospital (Blumenthal and Glaser 2007, Delingette and Ayache 2005, Varshney 2007). The introduction of Internet based IT innovations, widespread high bandwidth mobile networks, and small smartphones with high data processing capabilities, have created new channels of communication for healthcare professionals and patients (Wickramasinghe 2011).

Despite the progress in the adoption and diffusion of IT innovations in hospitals, the level of IT remains variable across healthcare settings and challenging to gauge (Aas 2007, Jaana, Pare and Sicotte 2009). Healthcare is a large and complex environment, and the diffusion of IT innovations encounters numerous barriers. Even with its potential to lower costs and transform healthcare, the technical, economic, organisational, and knowledge barriers seem to hinder the adoption and diffusion of IT innovations (Glasgow 2007).

Rogers identifies that health innovations generally diffuse slowly and have greater diffusion difficulties, even though there is no doubt that about the benefits of the innovation if it were adopted. In an interview with McGrath and Zell, Rogers states (p. 388): (2001) "One of the challenges for future diffusion research is to study innovations that would contribute to the public good but that diffuse slowly."

The adoption and diffusion of IT innovations in healthcare is slow.

The research question thus is: Can we stimulate the adoption and diffusion of IT innovations in healthcare?

1.2. Multi-level theory, mixed levels of analysis, case study, and triangulation

The adoption and diffusion of IT innovations in healthcare affects organisations at different levels. Therefore, the current research uses multi-level theory and mixed levels of analysis, case study, and triangulation.

Mixed levels of analysis

Markus and Robey (1988) argue that researchers should use multiple and complementary approaches to capture and understand the complex and evolving IT. They should develop sounder theories, and build a cumulative tradition, suggesting that more emphasis on multi-level theory building would likely improve empirical reliability. Also researchers should actively pursue more innovation, realism, and interaction with the rest of the world. Innovation can easily be found beyond the computer and the CIO's office (Fichman 2000, Fichman 2004, Lee 2004, Vogel, Van Genuchten and Saunders 2009).

Similar to Markus and Robey (1988), Pare, Bourdeau, Marsan, Nach and Shuraida (2008) argue that IT impacts in organisations are difficult to confine to a single level of analysis, and suggest that researchers should use mixed levels of analysis. Adopting this multi-level perspective gives researchers a complementary viewpoint when studying IT innovations through a focus on the dynamic interplay between individuals, technologies, and larger organisational and social constructs (Greenhalgh, Robert, Macfarlane, Bate and Kyriakidou 2004).

IT in healthcare needs to be understood more as a large-scale program to transform the culture of healthcare, rather than be narrowly defined as an IT enabled project evaluated on a narrow set of quantitative key performance indicators (Bashshur 1995, Currie and Guah 2006).

Aoki, Dunn, Johnson-Throop and Turley (2003) reviewed 112 e-health evaluations, concluding that there are a number of good reports on diagnostic accuracy, satisfaction, and technological evaluation. However, clinical effectiveness and cost-effectiveness are important parameters, and they have received limited attention according to Aoki, et al. (2003) (p. 393) "Since e-health evaluations tend to explore various outcomes, it may be appropriate to evaluate from a multidisciplinary perspective, and to utilize various methodologies."

Hailey, Ohinmaa and Roine (2004) identified 605 publications in a literature search on economic analysis of e-health. The authors comment that although further useful clinical and economic outcomes data have been obtained for some applications, good-quality studies are still scarce.

Hersh, Helfand Wallace, Kraemer, Patterson, Shapiro and Greenlick (2001) completed a systematic review of clinical outcomes focusing on three sets of clinical applications. The authors concluded that "the methodological quality of these studies was generally 'low' ". Hersh et al. (2001) (p. 3) suggested further randomized controlled trials must be done to determine where its use is most effective.

Gagnon, Lamothe, Fortin, Cloutier, Godin, Gagné and Reinharz, (2005) and Gagnon and Scott (2005) (p. 34) argue that e-health evaluation is often criticized for the poor quality of research design, the lack of common outcome indicators, and the absence of an agreed theory. Evaluators - and decision makers – encounter that e-health evaluation may serve different purposes for different stakeholders, "and therefore concede that no single evaluation framework or methodology, even the randomized controlled trial, is totally objective".

Venkatesh (2003) reviewed user acceptance literature and discussed, and empirically compared eight prominent models and their extensions formulating a unified model. The unified model provides a useful tool for managers needing to assess the likelihood of success for new technology introductions and helps them understand the drivers of acceptance in order to proactively design interventions targeted at populations of users. The unified model integrates elements across the theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behaviour, a model combining the technology acceptance model and the theory of planned behaviour, the model of PC utilization, the innovation diffusion theory, and the social cognitive theory.

Kohli and Grover (2008) argue that as businesses and customers are the final arbitrators of value creation, by overemphasizing pure financial post hoc metrics or even ex ante market value, researchers underreport the true benefits of IT to these stakeholders. The intangible benefits created by IT innovations are becoming increasingly important – and in many ways, our measurement instruments are too coarse to capture it.

Rogers' (1983, 2003) main school of thought on innovation adoption and diffusion theory, combined with theory on frameworks in the emerging field of e-health, are applied to analyse the adoption and diffusion of IT innovations in healthcare.

Case study

Non-experimental designs differ from quasi-experimental designs in that they do not attempt to simulate the conditions of a controlled experiment. They include case study, case series, and correlational designs. Siden (1998) argues that non-experimental designs are unable of confirming causal effects and that well-designed observational studies with large probability samples of the general population using qualitative methods, including focus groups, may yield important data on complex behaviour and explore attitudes toward new and unfamiliar technology.

Mintzberg (1973) suggests that researchers go to the field for insights. Case study (Yin 1994, Yin 1999) can be used for its potential to yielding useful field insights on the basis of the in-depth analysis of the cases under observation and generation of hypotheses for further investigation.

Longitudinal case study is used in this research to generate useful insights into adoption and diffusion of an IT innovation in healthcare. Based on the in-depth analysis of two cases in The Netherlands, propositions are generated for further investigation.

Triangulation

Bashshur, (1995) Bashshur and Shannon (2005) and Denzin and Lincoln (1994) advocate the triangulation method. This method has the central assumption that the weaknesses in each single method (quantitative and qualitative) will be compensated by the counter-balancing strengths of the other one. It is a delicate exercise that allows enhancement of the accuracy between observations.

The ‘between’-method has been selected, allowing cross validation using diverse methods. Triangulation will capture a phenomenon that we characterize as being slow, and therefore requires a longitudinal study. This approach is needed since no single evaluation framework or methodology can serve different purposes for different stakeholders (Gagnon, et al. 2005, Gagnon and Scott 2005). This research focuses on the interplay between individuals, technologies, and larger organisational and social constructs to provide a complementary viewpoint.

Triangulation is used in this research to capture the slow phenomenon of adoption and diffusion of IT innovation in healthcare. More specifically, this research applies Denzin and Lincoln’s (1994) basic types of triangulation:

(i) Data triangulation: the data collected in this research involves different periods in time, hospitals, and participants.

(ii) Investigator triangulation: the author of this dissertation is the main researcher; however, multiple researchers were involved, primarily in the data collection process and the analysis of the interviews (double coding);

(iii) Theory triangulation: this research involves using more than one theoretical frameworks in the interpretation of the phenomena: combining theory from innovation, economic, organisation, Information Systems (IS) and healthcare literature.

(iv) Methodological triangulation: this research involves several methods to collect data: the combination of a longitudinal case study analysis of adoption and diffusion of an IT innovation in healthcare, and a nationwide market analysis on the adoption and diffusion of an IT innovation in healthcare over a period of 10 years, generating propositions for further in-depth investigation on IT alignment in hospitals.

As Table 1 indicates, in total, over 150 participants from the field of healthcare - from patient to management – contributed to this research.

Table 1 Triangulation; structure, methodology, level of analysis and participants

Chapter	Description	Level of analysis	Methodology N
Chapter 4 Case study analysis	- 4.1 Longitudinal case study of the implementation of the VBVS in the Netherlands (one university and one top-clinical hospital).	Hospital	Case study (2)
	- 4.1.1 Additional two focus group sessions (GroupSystems, video recorded) with stakeholders discussing traditional communication versus communication with innovative IT (20 participants) one case study.	Healthcare IT stakeholders	Focus group (20)
	- 4.1.1. Additional a survey (Appendix B) including 27 parents in one case study.	Patient	Survey (27)
Chapter 5 Market analysis	- 5.1 Nationwide market analysis by survey on the VBVS in 93 hospitals in the Netherlands.	Hospital	Survey (93)
	- 5.1 Additional: a mini-symposium with stakeholders (56 participants).	Healthcare IT stakeholders	Mini-symposium (56)
Chapter 6 Exploring adoption and diffusion of IT innovation in healthcare	- 6.1 Interviews with IT management in hospitals in the Netherlands (8 university and 8 top-clinical hospitals representing 40% of the hospital market) on the IT innovation decision making process and IT alignment.	Hospital IT management	Semi structured interview (double coding) (16)

This research is structured in the following way:

Chapter 1 introduces the problem area, research question and research methodology of this dissertation: the adoption and diffusion of IT innovations in healthcare.

Chapter 2 defines innovation, adoption and diffusion. It describes the European policy on IT innovations and the economic conceptualisation of IT innovations.

Chapter 3 defines e-health as an IT innovation in healthcare, presents the theoretical frameworks on e-health, and concludes with the evaluation of main barriers in adoption and diffusion of e-health, with a focus on intangible benefits in the IT innovation investment decision-making process.

Chapter 4 generates in-depth insight into the adoption and diffusion of an IT innovation in healthcare, presenting a longitudinal case study in two hospitals in the Netherlands.

Chapter 5 presents a market analysis on the adoption and diffusion an IT innovation in healthcare in the Netherlands over a period of almost 10 years, and generates propositions for further in-depth investigation of the adoption and diffusion of IT innovation and IT alignment in hospitals.

Chapter 6 presents an in-depth investigation on the adoption and diffusion of IT innovations in healthcare. A focus group of IT management in hospitals is interviewed with the emphasis on elements of the IT innovation decision-making process, the influence of the financial resources, IT alignment, the perceived innovativeness, and the perceived personal innovativeness on the adoption and diffusion of IT innovations.

Chapter 7 integrates and discusses the outcomes and limitations of this research, and presents the conclusions of this research and concludes with suggestions for further research.

1.3. Summary

This chapter addressed the problem of increasing cost of healthcare forcing healthcare organisations to modify their business to remain competitive. IT innovations introduce new channels of communication to deliver or enhance health services, and have the potential to revolutionise healthcare and contribute to its sustainability.

The adoption and diffusion of IT innovations affects healthcare organisations at different levels. The current research uses multi-level theory and mixed levels of analysis, case study, and triangulation, are applied in this research.

In the following chapter the economic conceptualisation of IT innovations in healthcare is presented.

CHAPTER 2

IT Innovation And Economic Conceptualization In Healthcare

"I have no restrictions. No bottleneck when it comes to money, up till' now. Our organisation is an example of an organisation that can do a lot with IT because there is budget. It goes hand in hand, the power of the organisation and the money.

Head of IT, university hospital (subject 9)

This chapter presents the literature for the theoretical frameworks on adoption and diffusion of IT innovation, economic conceptualisation of IT innovations, IT stakeholders in healthcare, IT alignment in healthcare.

On a process level, healthcare has unparalleled complexity. This complexity is mirrored in the healthcare IT innovation decision-making process, where stakeholders may have embedded conflict of interest.

In literature, the definition of innovation, and diffusion and adoption has a rich tradition around Rogers' (1983, 2003) main school of thought. Adoption and diffusion of innovations follow a typical innovation decision-making process and adopters are categorized by a model, led by normal distribution[1]. In real life we find a chasm in the early stages of adoption. Crossing this chasm has been an important topic on the policy agenda of the European Union, expecting that IT innovations can help to provide better patient centred care as well as lower cost of healthcare delivery.

[1] or Gaussian, after Johann Carl Friedrich Gauss, 1777 -1855, a German mathematician and scientist.

An action plan on a European level provides outlines for national policies. In their latest policy statement the Dutch Department of Healthcare states that IT innovations can enable changes in the healthcare delivery process, needed to guarantee access in the future.

The investments in IT within healthcare have grown rapidly, albeit IT infrastructure and services in healthcare are suggested to be 10–15 years behind other industries. Healthcare, as other industries, faces the IT productivity-paradox. Typically IT investments have a cumulative effect over time, which can only be captured through repeated observations. Also pure financial post-hoc metrics or even ex-ante market value, underreport the intangible benefits of IT to stakeholders. These intangible benefits are becoming increasingly important – and in many cases our measurement instruments are too course to capture it.

In healthcare IT investments being cost neutral could be a more-than-sufficient justification for making the investments: improved quality at constant cost; emphasizing the need for IT alignment in healthcare. Generic alignment models such as the Massachusetts Institute of Technology (MIT) "Diamond" model or the Strategic Alignment Model (SAM) can support healthcare management aligning the IT innovation decision process. However, healthcare in its nature deals with unexpected outcome. Therefore specific e-health frameworks are used to enhance the traditional IT alignment models to allow a more healthcare specific classification and analysis.

2.1. Definitions: innovation, adoption and diffusion

Innovation, a broad and often used term, from an economic perspective, can be defined (Schumpeter 1934) as:

(i) "The introduction of a new good — that is one with which consumers are not yet familiar — or of a new quality of a good:

(ii) The introduction of a new method of production, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially;

(iii) The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before;

(iv) The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created.

(v) The carrying out of the new organisation of any industry, like the creation of a monopoly position or the breaking up of a monopoly position."

Lyytinen and Rose (2003) and Swanson (1994) (p.1072) define IT innovation as "*an innovation in digital and communications technologies and their applications*".

Thakur, Hsu and Forntenot (2012) (p. 564) define healthcare innovation in a more narrow sense as "*those changes that help healthcare practitioners focus on the patient by helping healthcare professionals work smarter, faster, better and more cost effectively*."

Roger's (2003) innovation decision process theory describes a process that occurs over time through five stages, a process through which an individual or other decision-making unit passes:

(i) Knowledge (initiation): from first knowledge of an innovation;

(ii) Persuasion: forming an attitude toward the innovation;

(iii)Decision: a decision to adopt or reject;

(iv)Implementation: implementation of the new idea;

(v) Confirmation: confirmation of this decision.

These five stages are used for the analysis of the case study presented in Chapter 4.

Rogers (2003) (p.5) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system." Once innovation occurs, innovations may be spread from the innovator to other individuals and groups. Customers respond to new products in different ways.

The technology adoption lifecycle is a sociological model, originally developed by Beal and Bohlen (1957), and Bohler, Coughenour, Lionberger, Moe and Rogers (1961). Its purpose was to track the purchase patterns of hybrid seed corn by farmers. The technology adoption lifecycle model describes the adoption or acceptance of a new product or innovation, according to the demographic and psychological characteristics of defined adopter groups.

The model indicates that the first group of people to use a new product is called "Innovators," followed by "Early Adopters." Next come the "Early and Late Majority," and the last group to eventually adopt a product are called "Laggards."

The report summarises (see Figure 3) the categories as:

(i) "Innovators - had larger farms, were more educated, more prosperous and more risk-oriented; 2,5%

(ii) Early Adopters - younger, more educated, tended to be community leaders; 13,5%

(iii) Early Majority - more conservative but open to new ideas, active in community and influence to neighbours; 34%

(iv) Late Majority - older, less educated, fairly conservative and less socially active; 34%

(v) Laggards - very conservative, smalls farms and capital, oldest and least educated; 16%"

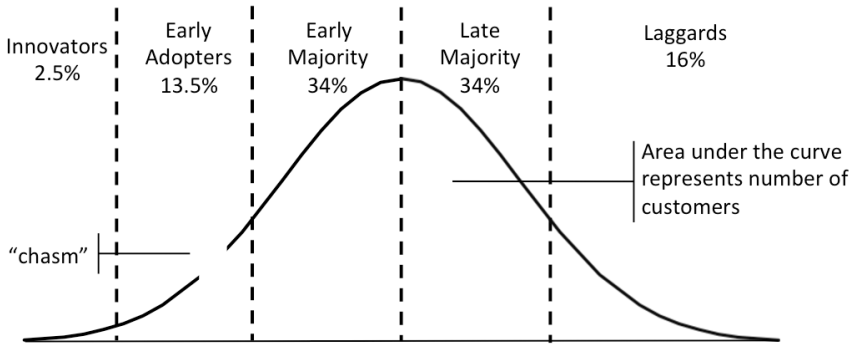


Figure 3: Technology adoption curve; normal distribution

The process of adoption over time is typically illustrated (see Figure 3) as a classical normal distribution curve; well-known to statisticians. The percentages represent the distribution of adoption over time; Innovators (2.5%) and Early Adopters (13.5%) form 16% of the number of cases, Early Majority and Late Majority each 34%, and Laggards 16%.

Rogers' (1983, 2003) theory can be challenged in that the basic invention-innovation-diffusion model does not always fit the multi-level, non-linear processes that stakeholders participate in to create successful and sustainable innovations.

Technology adoption and diffusion typically occurs in an s-curve (see Figure 4), as modelled in the diffusion of innovations theory. Diffusion of innovations theory suggests that people have different levels of readiness for adopting new innovations and that the characteristics of a product affect overall adoption.

The s-curve is derived from half of a normal distribution curve. There is an assumption that new products are likely to have "product Life" i.e., a start-up phase, a rapid increase in revenue, and eventual decline. In fact, the great majority of innovations never get off the bottom of the curve, and never produce normal returns. The speed of technology adoption is determined by two characteristics: the speed at which adoption takes off, and the speed at which later growth occurs. A cheaper technology might take off more quickly, while a technology that has network effects (such as WhatsApp or Facebook, where the value of the IT innovation increases as others get it) may have a speed at which later growth occurs.

In the early stage of a particular innovation, growth of competitive advantage is relatively slow as the new product establishes itself. At some point customers begin to demand, and the product growth increases more rapidly.

New incremental innovations or changes to the product allow growth to continue. Towards the end of its life cycle growth slows and may even begin to decline. In the later stages, no amount of new investment in that product will yield an increase in competitive advantage.

The s-curve maps, (see Figure 4) Competitive Advantage against Time and Investment.

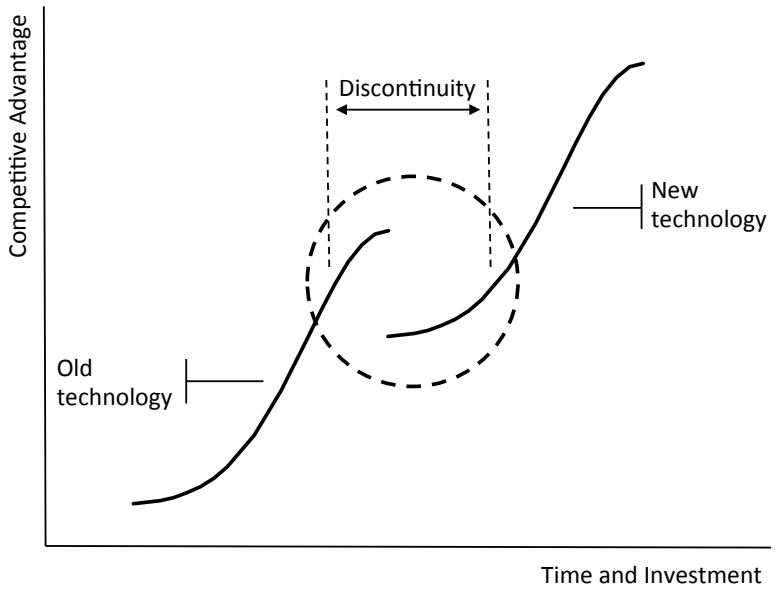


Figure 4: Step-change technology

Critics of the step-change technology model have suggested that it is an overly simplified representation of a complex reality. Innovative companies will typically be working on new innovations that will eventually replace older ones. Successive s-curves will come along to replace older ones and continue to drive growth upwards. A number of other phenomena can influence innovation adoption rates. Customers often adapt technology to their own needs, and thus the innovation may actually change in nature from Early Adopters to the Majority of users.

In *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers* Moore (1991) argues that there is a chasm between the Early Adopters of the product and the Early Majority as presented in Figure 3.

Visionaries and pragmatists have very different expectations. Moore (1991) explores these differences and suggests techniques to successfully cross the chasm, including choosing a target market, understanding the whole product concept, positioning the product, building a marketing strategy, and choosing the most appropriate distribution channel and pricing (Fichman and Kemerer 1999). *Crossing the Chasm* is closely related to Roger's technology adoption lifecycle. Adoption of continuous innovations (that do not force a significant change of behaviour by customer) is best described by the original technology adoption lifecycle. Most new technologies follow a similar technology lifecycle describing the technological maturity of a product. This is not similar to a product life cycle, but applies to an entire technology or a generation of a technology.

Fichman (2000) defines (p. 1) Diffusion as "*the process by which a technology spreads across a population of organizations*" while assimilation refers to "*the process within organizations stretching from initial awareness of the innovation, to potentially, formal adoption and full-scale deployment*". The Guttman-scale for of healthcare innovations is commonly used for measuring assimilation (Meyer and Goes 1988). At the DIGIT Conference December 14, 2003 Fichman (2003) addressed the question "Should the IT Assimilation Concept Span the Adoption Lifecycle?" arguing that already a large variety of terms for the post-adoption process exists and the other alternatives for a lifecycle-spanning terminology (i.e. adoption process, implementation process, and innovation process) have problems. He argues that the used theory should discriminate among stages and does not assume that greater/faster assimilation is better or rejects "discretionary" discontinuance.

2.2. European policy, and economic conceptualisation of IT innovation

This section addresses the current policy IT innovation from an economic perspective in Europe and the Netherlands.

In the 3th Oslo Manual (2005) the OECD takes a wide perspective to innovation; including marketing and organisational innovation, although the main measure for innovation is traditionally expenditure in percentage of GDP.

In *Europe 2020; A strategy for smart, sustainable and inclusive growth* (2010b) the European Union announced 3% of their GDP (public and private combined) to be invested in research and development, and innovation. Whether this was a good measurement of innovation has been widely discussed, and the Oslo Manual has incorporated some critiques against earlier methods of measuring. This being said, the traditional methods of measuring still inform many policy decisions.

To support the goal "Smart growth – an economy based on knowledge and innovation" one of the European Union flagship initiatives is *A Digital Agenda for Europe* (2010a). The aim is to "deliver sustainable economic and social benefits from a digital single market based on fast and ultra fast internet and interoperable applications, with broadband access for all by 2013, access for all to much higher internet speeds (30 Mbps or above) by 2020, and 50% or more of European households subscribing to internet connections above 100 Mbps.

At national level, Member States will need to promote deployment and usage of modern accessible online services (e.g., e-government, online health, smart home, digital skills, security)."

With their projection Together for Health: A Strategic Approach for the EU 2008-2013 (2007) the European Union aims to support dynamic health systems and new technologies. European Union health systems are under mounting pressure to respond to the challenges of population ageing, patients' rising expectations, migration, and mobility of patients and health professionals. The European Union expects that IT innovations such as e-health, genomics and biotechnologies can improve prevention of illness, delivery of treatment, and support a shift from hospital care to prevention and primary care. More specific, e-health can help to provide better patient-centred care as well as lowering costs and supporting interoperability across national boundaries, facilitating patient mobility and safety.

Despite the optimism, the European Union expresses (2007) (p. 9) a warning: “Nevertheless, new technologies must be evaluated properly, including cost-effectiveness and equity, and health professionals' training and capacity implications must be considered. New and unfamiliar technologies can generate ethical concerns, and issues such as trust and confidence, must be addressed.”

To boost investment in health systems, e-health has been integrated into instruments aimed at enhancing European Union. These instruments are growth, employment, and innovation, the 7th Framework Programme for Research (including the Joint Technology Initiative on Innovative Medicines), the Competitiveness and Innovation Programme, and Regional Policy. However, further action is needed, e.g., in relation to the capacities of regions, which are key actors in delivering healthcare.

In their *Action plan for a European e-Health* (2004) *Making healthcare better for European citizens: An action plan for a European e-health Area* the European Union envisions e-Health as today's tool for substantial productivity gains, while providing tomorrow's instrument for restructured, patient-centred health systems and, at the same time, respecting the diversity of Europe's multi-cultural, multi-lingual health care traditions.

European Community research programmes have been supporting e-health for the last fifteen years. The co-financing allocated since the early 1990s has reached €500 million, with a total budget about twice that amount. Many research results have now been tested and put into practice. This has put Europe in a leading position in the use of electronic health records and deployment of healthcare cards. These developments have contributed, according to the European Community, to the emergence of (2004) (p. 4) "a e-health industry that has the potential to be the third largest industry in the health sector with a turnover of €11 billion. By 2010 it could account for 5% of the total health budget. At present, the e-health industry in Europe – mainly made up of small- and medium-sized enterprises – has a competitive advantage, but it still needs to enjoy a more favourable business environment."

In *Perspectief op Gezondheid 20/20* (2010), the Dutch council of healthcare addresses the main challenges in the Dutch healthcare system for the coming decade. They distinguish the following forces: two accelerators (increasing demand for healthcare and medical possibilities) and two decelerators (financial crisis and healthcare workforce). It is the combination of these four forces and their interaction. Furthermore, the council suggests that medical technology and IT are radical and autonomous forces from a global knowledge driven environment. The information that Internet holds will change healthcare in 2010-2020 from the healthcare, as we currently know it.

In their latest (2011) policy statement *Headlines of the healthcare policy to 2020,* the Dutch Department of Healthcare states that e-health can enable changes in the healthcare delivery processes that are needed to guarantee access to healthcare in the future. The department of healthcare emphasizes that there is a great need for patients - from the comfort of their home - to ask healthcare related questions, initiate treatment, and obtain monitoring services so that hospitalisation can be shortened or postponed. Healthcare stakeholders; patients, healthcare professionals and healthcare insurance companies have set the national e-health agenda (KNMG/NPCF/ZN 2012) to stimulate the use of e-health. Key elements are standardization and patient involvement.

Productivity paradox

In the 1970s and early 1980s, the bulk of information and IT investment was on national research for demonstration projects, business management systems, as well as mainly stand alone departmental projects. These were usually administrative support systems, although some were clinical. Very few systems were designed for community-based or general practitioner services.

Throughout the 1980s, investment in IT in the health sector grew, but it was not until the health system organisational reforms in the early 1990s that information was perceived as being a vital resource. The pressure of containing costs of healthcare and improving delivered services in the face of increased demand led to these administrative reforms, including the split between purchasers and providers of care, and attempts to professionalize health services management (Klecun and Cornford 2003).

Garets and Lieber (2005) report that with at least equal (or higher) complexity, healthcare spends 2.3%, while financial services spends 7.5% of their revenue on IT. They report that the average hospital IT cost as a percentage of revenue does not exceed 3% for any bed size range or any segment of hospitals based on region (e.g., urban or rural) or function (e.g., university, non-university, general medical, not general medical). More recent data captured in a joint study conducted by The Scottsdale Institute, HIMSS Analytics, and Lawson Software found that hospitals with effective IT governance structures and industry leading IT environments spend more than 3% of their annual revenue in IT.

IT infrastructure and services in healthcare are suggested to be 10–15 years behind other industries, such as financial services, manufacturing and even transportation (Raghupathi 2007, Raghupathi and Tan 2002). Although countries spending an relative high percentage of their GDP on healthcare, healthcare organizations currently invest less in IT than in any other information-intensive industry (Bates 2002), they are closer to that of the transportation industry than to banking and finance (Gomolski 2010) as presented in Table 2.

Table 2: IT Investment by Industry Worldwide (x 1.000.000.000 USD)

Vertical market	2007	2008	2009	2010	% 2010
Financial Services	524	548	503	516	22%
Public Sector	439	464	443	460	20%
Manufacturing	448	471	433	436	19%
Communications	202	215	202	206	9%
Retail	217	227	211	214	9%
Services	171	182	172	175	7%
Utilities	116	122	114	118	5%
Transportation	104	109	100	102	4%
Healthcare	80	85	80	82	4%
Agriculture, mining, and construction	28	28	25	26	1%
Total	2,328	2,451	2,283	2,335	100%

Not all service industries benefit from the introduction of IT in the same way or to the same extent. Health care is labour-intensive. While many manufacturing processes can be automated, it is not yet possible to automate the work done by physicians and the other highly educated individuals who make up the health care work force.

Attewell argues (1994) that IT can have negative or insignificant impacts on firm productivity (the productivity paradox), while having positive and significant impacts on others, thus substantiating the value of IT. In healthcare, from 1973 and through the 1990s, there was little evidence that IT investments had a significant effect on productivity (Grigsby, Rigby, Hiemstra, House, Olsson and Whitten 2002).

It seems logical that when GDP rises, IT investment will also rise (Paavola 2007). Therefore, the traditional view of healthcare on IT investment as percentage of GDP is not an adequate measure, since it is only remotely related to the healthcare outcome (Borzekowski 2002, Remenyi 1999, Remenyi, Sherwood-Smith and White 1997).

Brynjolfson argues (2000) that IT innovations can have a positive effect on individual firms' productivity. To the extent that there is disagreement about the returns of IT, it can be explained by the difficulties in conceptualizing and measuring IT, and the relevant business outcomes. The difficulty is that IT investments most likely have a cumulative effect over time, which can be only captured through repeated observations. In addition, there are many organisational issues that can interfere with the direct translation of IT investment in IT capabilities.

As healthcare moves up the IT Capital Index scale, IT investments show a levelling off of costs. In healthcare IT investments being cost neutral could be a more-than-sufficient justification for making the investments: improved quality at constant cost. As hospitals move into "high adopter" categories, there is very strong evidence that they enter a cost-reducing relationship with IT investments. This is consistent with the idea of network effects, that is, incremental additions of IT contribute directly to the processes they are targeting, and, at the same time, they make pre-existing IT at the hospital more valuable.

Management should not justify expensive new IT investments purely on the assumption that these investments will create huge and rapid paybacks for the organisation. If anything, management should use these results to justify moving along the IT opportunities matrix to a position where future IT investments at least pay for themselves (Beard and Elo 2007).

Setia, Setia, Krishnan, and Sambamurthy (2011) suggest that the length of experience with use of specific IT innovations has a more significant positive impact the hospitals' financial performance than the adoption of a broad array of IT innovations. The effects differ across the business and clinical process domains.

IT may have been introduced into health care in ways that counter improvements in productivity. In some cases, healthcare professionals must spend more time to accomplish the same amount of work, as, for example, has been the case with the introduction of many electronic medical record systems. There may well be a trade-off between the quality of the patient experience and the use of clinical time. When a technology is not at least as convenient as the process it is intended to replace, productivity suffers (Grigsby, et al. 2002).

Devaraj and Kohli (2003) argue that in many cases, due to the nature of the research design employed, this stream of research has been unable to identify the impact of individual technologies on organisational performance. The driver of IT impact is not the investment in the technology, but the actual usage of the technology. Technology usage was positively and significantly associated with measures of hospital revenue and quality, and this effect occurred after time lags (three months or more). They suggest that actual usage may be a key variable in explaining the impact of technology on performance, implying that omission of this variable may be a missing link in IT productivity analyses.

Kohli and Grover (2008) argue that much of the work on the business value of IT has examined relationships between IT inputs and economic outcomes of the firm. They argue that as businesses and customers are the final arbitrators of value creation, and by overemphasizing pure financial post hoc metrics or even ex ante market value, researchers underreport the intangible benefits of IT to these stakeholders.

2.3. IT stakeholders in healthcare

Complexity

On a process level healthcare has an unparalleled complexity. For example, in a hospital, open 24/7, with 400 million Euro annual budget, 40,000 clinical visits, and 400,000 ambulatory care visits, partially acute, handled by 4,000 employees, including 400 physicians that may order one of 2,500 medications, there are 1,100 clinical laboratory tests, 300 radiology procedures, and a large numbers of other tests and procedures.

The variability within a pathway is compounded by the diversity of diseases and complications. There are 1,000 diseases, each of which, in theory, has different steps and decision points based on medical guidelines, recent evidence, and expert consensus resulting in a care map that shows the complete patient journey for that disease.

The International Statistical Classification of Diseases and Related Health Problems (ICD-10) (World Health Organisation 2007) code set allows more than 14,400 different codes, and permits the tracking of many new diagnoses.

This variability is unparalleled by any other manufacturing process. No carmaker produces 1,000 different models of cars or provides for each model 2,500 different types of paint, 300 different arrangements of wheels, or 1,100 different locations for the driver's seat (Glaser and Hsu 1999).

Stakeholders

The complexity of healthcare also lies partially in the stakeholder structure, usually in the mix of a private and public setting, which has embedded conflicts of interest. The patient pays a premium for healthcare insurance. A healthcare insurance company exercises its purchasing power over the healthcare providers. Typically, the healthcare provider delivers healthcare service to the healthcare consumer, and the government defines and enforces the national healthcare policy (Thakur, et al. 2012).

Success and failure of IT has a tradition in research, with Lucas (1995), and Lucas (1999) and Sauer, Southon and Dampney (1997) developing models of, and explanations for, this phenomenon. Lyytinen and Hirschheim (1987) define information system failure as "the inability of an IS to meet a specific stakeholder group's expectations.". The stakeholder concept is also introduced by Fletcher, Guthrie, Steane, Roos and Pike 2003 (2003) and Freeman (1984) and Mitroff (1983). Mitroff implies that an analysis could include a very large number of stakeholders, encompassing organisations, units within them, and individuals. Others, like Bryson (2004), also take an inclusive approach urging consideration of a broader array of people, groups or organisations as stakeholders, including the 'nominally powerless'.

In contrast, Eden and Ackermann (1998) take a utilitarian approach to stakeholder analysis, with the aim of "identifying stakeholders who will, or can be persuaded to, actively support the strategic intent of the organisation" that is, prioritising them.

Fichman (1992) reviewed eighteen empirical studies (1981-1991) on adoption and diffusion of IT, and based on that, developed a conceptual framework. The main difference with classical theory is that the adoption and diffusion of IT can be encouraged by management, has different levels, and may depend on the dynamics of community-wide levels of adoption and diffusion.

Pouloudi (1999) reviewed the descriptive and instrumental approach and argues for a more thorough understanding of the stakeholder concept. A more holistic view of stakeholders in IS reflects the current multi-faceted concerns. This holistic view is expected to contribute not only in addressing organisational and cultural issues, but also to encourage a more ethical approach, especially in a complex environment such as healthcare.

Boonstra (2006) developed and tested a model of stakeholder management, showing how stakeholders varied in their power to affect the use of the system, and in their interest towards its use. These attitudes reflected stakeholders' beliefs about the effects of the system on working routines, power, culture, and finance.

Mantzana (2007) introduced a structured method identify stakeholders in healthcare using a static and then a dynamic step to pull out the individual, group, organisational and human determinants. In this process, the individual actors' differing views emerge which could enable decision-making bodies to produce more robust proposals if they incorporated some of the appropriate views.

In healthcare, two general levels of IT stakeholder networks can be distinguished as presented in Figure 5 (Hasselbring, et al. 2000, Spanjers and Rutkowski 2001):

(i) Outer circle; the inter-organisational level composed of a minimum of three sub-levels (e.g., external stakeholders) such as health insurance companies/government, and IT vendors, and other healthcare organisations.

(ii) Inner circle; the intra-organisational level composed of a minimum of three sub-levels of network (e.g., internal stakeholders) involving actors such as healthcare professionals (such as physicians and nurses), IT department and management centred around the patient.

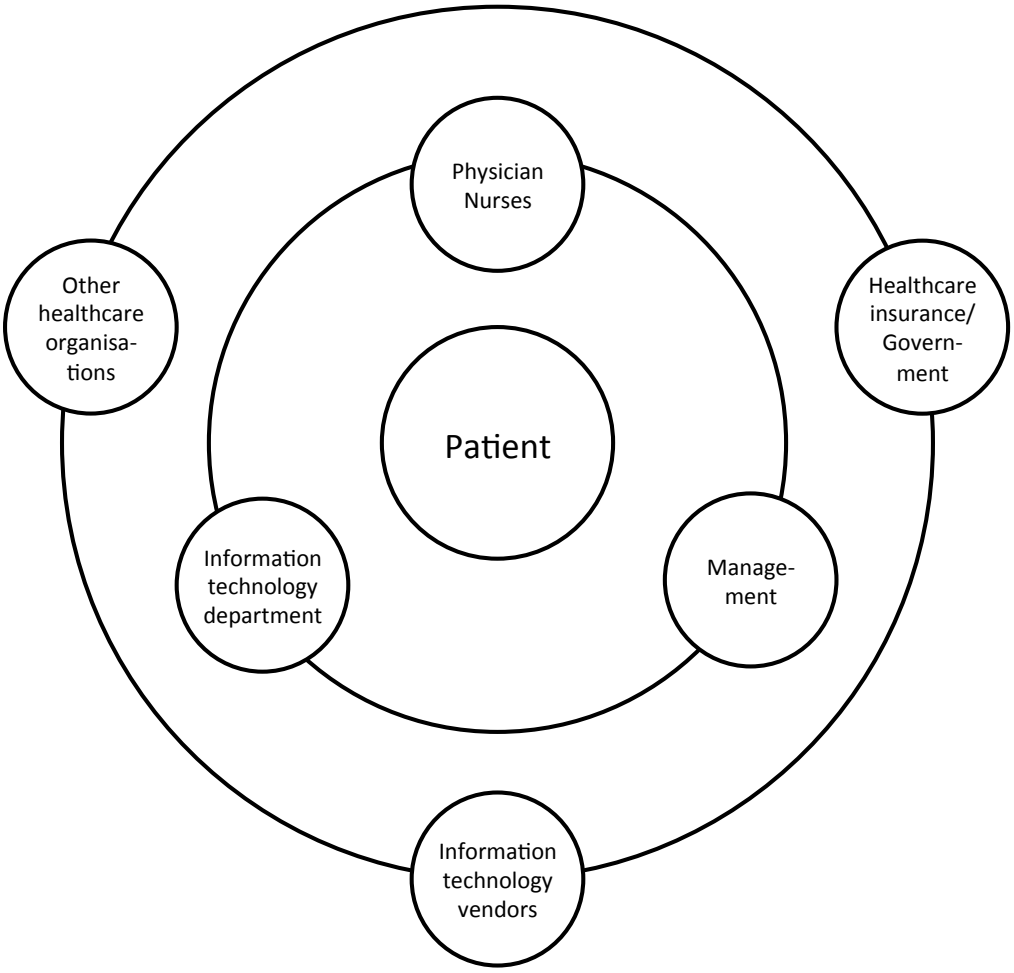


Figure 5: levels of stakeholder networks in e-health

Prasad and Prasad (1994) underline that the adoption of technology in health care organisations is influenced by instrumental consideration but also by non-instrumental factors such as culture or politics. Bayne (1997) purports that technology is far ahead of the health care professional's ability to improvise and use it.

Salvemini (1999) suggests that users participating in the design, testing, and critique of a system also increases the likelihood that the system will be accepted, and used after it is released.

Hu, Chau, Lui Cheng and Kar Yan, (1999) evaluated the technology acceptance model by examining the acceptance of e-health technology among physicians, and found it was able to provide a reasonable depiction of physicians' intention to use IT. Perceived usefulness was found to be a significant determinant of attitude and intention but perceived ease of use was not.

Kassirer (2000) suggests that healthcare professionals show high resistance to new technologies. The technology acceptance model, which is an "intention-based model, is developed specifically for explaining or predicting user acceptance of computer technology,"

Lapointe, Lamothe and Fortin (2002) and Gagnon Lamothe et al (2005) demonstrate that IT adoption and diffusion is negatively associated with physicians' control over administrative decisions. Time and careful planning was central in the approach Helitzer, Heath Maltrud, Sullivan and Alverson (2003) to avoid loss of cohesion and turbulence in the organisation due to the 'gimmick' effect of new technologies.

(IT) management plays an important enabling role in supporting organisational change in healthcare (Peterson, et al. 2000, Peterson, et al. 2001a, Peterson, et al. 2001b, Spanjers, et al. 2001).

Its culture typically starts out with a strong bureaucratic nature, characterized by high values for standardization, security, centralism, order and individual avoidance (Rockart 1982). Healthcare (IT) management in its role as enabler is mostly technically oriented and interested in clearly defined requirements for its work.

Generally, healthcare (IT) management formulates the IT policy resulting in a weak link with the strategy as a whole. When compared to all other industries, healthcare has slightly lower proportions of Innovators and Housekeepers. Survivors are slightly higher than the average of other industries. A large budget and large staff does not automatically lead to gains – time is still critical (Garets and Lieber 2005).

Thakur, et al (2012) argue that the decision makers align their decision-making strategy with the mission of the company that must also be compliant with government regulations. Those decision makers that use top–down management, make decisions easier but face more challenges when implementing those innovative decisions; those that use bottom–up management, have a more difficult time making the decisions but roll out adoptions easier and with more acceptances.

2.4. IT alignment in healthcare

In order to effectively use IT to create a competitive advantage, an organisation needs to understand, and integrate well, strategically, and tactically, the organisation's strategic context, the organisation's environment, the IT strategy and the IT portfolio (Galbraith 2002, Weil and Broadbent 1998, Willcocks and Lester 1999).

Henderson and Venkatraman (1993) and Campbell (2005) purport that alignment is the degree of fit and integration among business strategy, IT strategy, business infrastructure, and IT infrastructure.

Healthcare organisations are often positioned in a larger geographical, economical, and socio-political environment. Therefore, it is important to investigate the context in which IT innovation is taking place (Gagnon, et al. 2005, Gagnon and Scott 2005, Tulu, Chatterjee and Laxminarayan 2005, Tulu, Chatterjee and Maheshwari 2007).

The Massachusetts Institute of Technology (MIT) (see Figure 6) and Strategic Alignment Model (SAM) (see Figure 7) form the underlying theoretical framework.

“Diamond” (MIT) model

The results of the Massachusetts Institute of Technology (MIT) research program “Management in the 1990s” were published by Scott Morton (1991). The outcome was the MIT model (see Figure 6), more commonly know as “Diamond” model, suggesting a positive IT outcome when key elements of strategy, technology, structure, management processes and individuals and roles. In the “Diamond” model, management processes, such as the innovation decision-making process, take a central role. Their framework is embedded in the external technological and socio-economic environment.

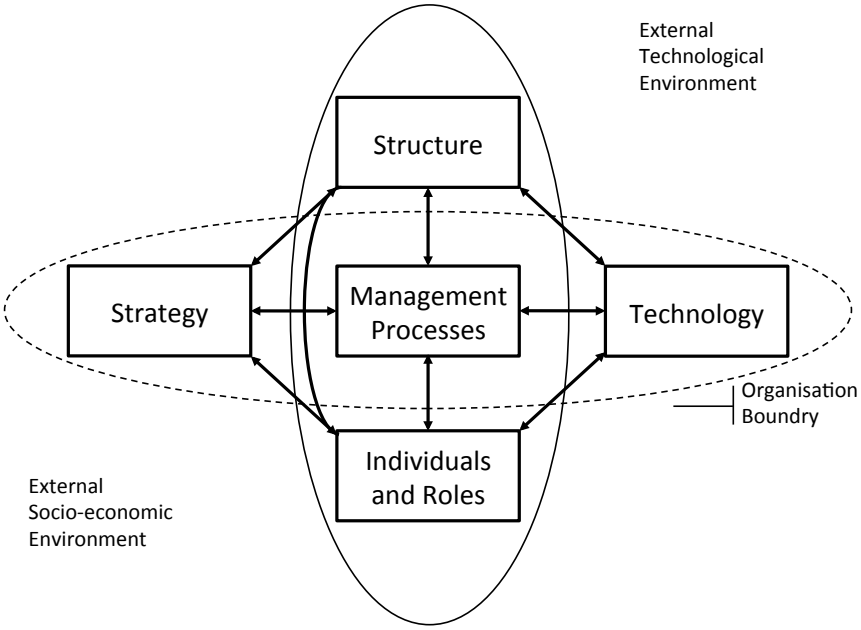


Figure 6: “Diamond” (MIT) model

SAM model

Henderson and Thomas (1992) were influenced by the MIT model developing the Strategic Alignment Model (SAM). The SAM model defines four key elements of strategy: 1) business strategy, 2) IT strategy, 3) organisation infrastructure and processes, and 4) IT infrastructure and processes as presented in Figure 7.

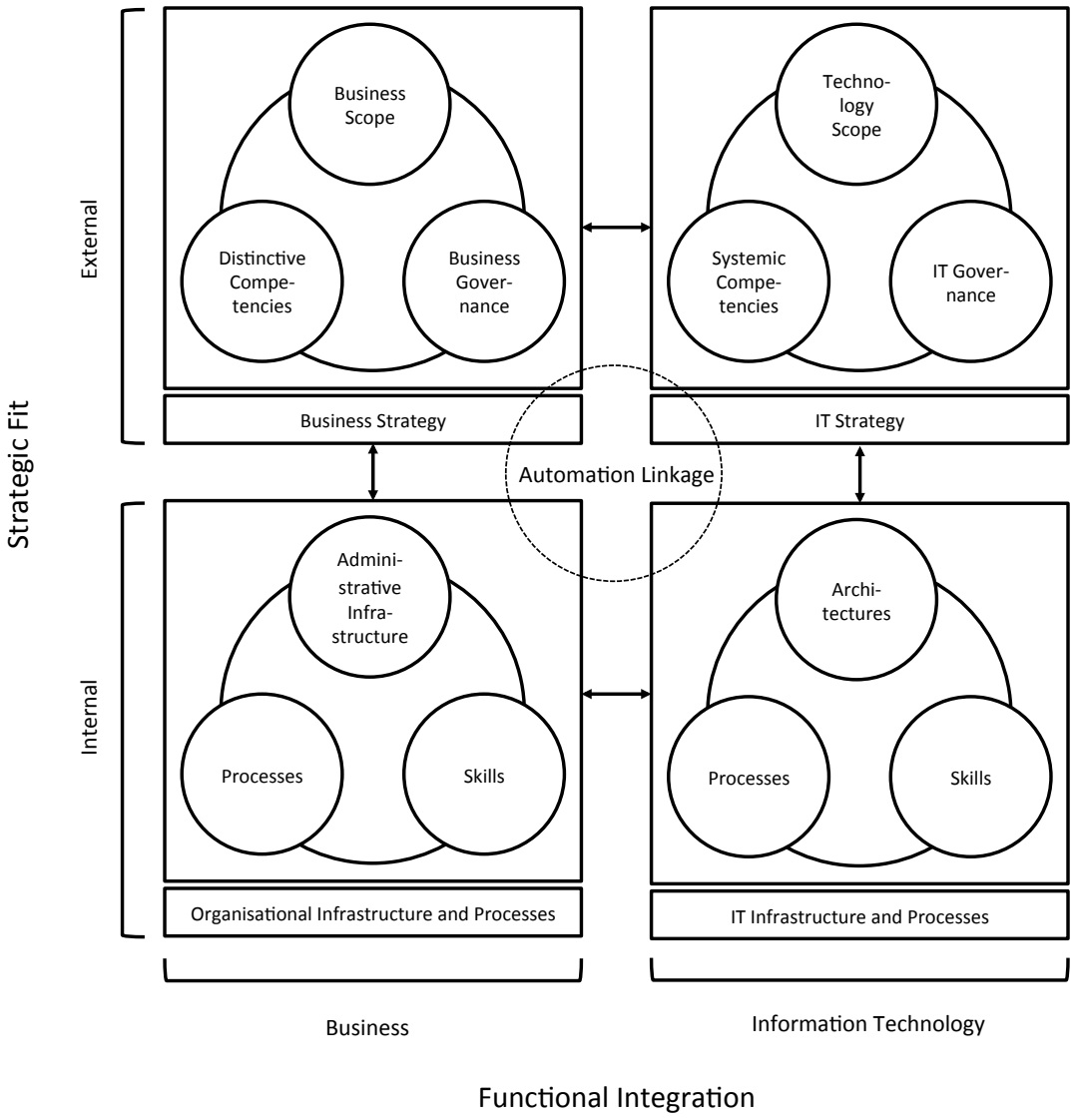


Figure 7: Strategic Alignment Model (SAM)

Ciborra (1997) suggests that the alignment literature can be theoretical; it is generated by the scientific method applied to the design of human affairs and computer systems. The use of technology is characterized by improvisations of and unexpected outcomes (Orlikowski 1996). Working toward pre-specified outcomes may be unrealistic, and Ciborra recommends a Mintzberg-like (1973) approach, where researchers go to the field for insights.

Leavitt and Whisler's (1958) article represents one of the first attempts to predict how organisational structures would be altered by IT. The studies of Mukhopadhyay, Kekre and Kalathur (1995), Robey and Boudreau (1999), and Kohli and Grover (2008) suggest further research on ways to generate reliable generalisation on the organisational transformations resulting from the adoption and diffusion of IT innovations. Hitt and Brynjolfson (1996) and Brynjolfson (2000) conclude that while modelling techniques need to be improved, there is no inherent contradiction between increased productivity, increased consumer value, and unchanged business profitability.

Markus and Benjamin (1996) emphasise that the increased behavioural flexibility of IS specialists would improve organisational effectiveness to make IT management more effective as agents of organisational change. Markus and Benjamin (1996) discovered widely differing views about what it means to be a change agent. IT managers do not always see the need to change; they already view themselves as effective change agents. The authors also found several structural barriers to change in the information system change-agentry role, especially overreliance on technical expertise, control authority, and an inappropriate reward system.

Despite these barriers, Markus and Benjamin remain (1996) optimistic that (IT) management is likely to be an effective change advocate with peers and superiors when the topic is structural change in the IT function, and this change will positively influence major organisational wide change efforts.

Chan and Reich (2007) research supports the hypothesis that the organisations that successfully align their business strategy with their IT strategy will outperform those that do not. However, counter-arguments presented by Chan and Reich claim that:

(i) alignment research is mechanistic and fails to capture real life,

(ii) alignment is not possible if the business strategy is unknown or in process,

(iii) alignment is not desirable as an end in itself since the business must always change, and

(iv) IT should challenge the business, not follow it.

Bush, Lederer, Li, Palmisano and Rao (2009) confirm alignment as a significant issue in health care organisations and suggests five broad alignment processes, actions and characteristics that facilitate and hinder the achievement of alignment for health care managers to align IT with objectives and strategy. The steps are: identify organisation objectives, identify organisation strategy, envision IT, and gain approval and implement.

Thakur, et al. (2012) argue that executives and practitioners should be open to any suggestions and/or changes, and they should align their decision-making strategy with the mission of the company while being compliant with government regulations. Also, to roll out innovations effectively, management should maintain a positive relationship with their employees and engage in extensive information sharing across organisational levels, by applying a bottom–up approach rather than solely emphasizing a top–down approach.

2.5. Summary

In this chapter the literature for the theoretical frameworks on the adoption and diffusion of IT innovation, economic conceptualisation of IT innovations, IT stakeholders in healthcare, IT alignment in healthcare is presented. Literature offers a rich tradition on the adoption and diffusion of IT innovations. The adoption and diffusion of IT innovations is embedded in the European Union policy. An action plan on a European level provides outlines for national policies. Due to complexity of healthcare on both a process and stakeholder level, the outcome of such policies remain uncertain; emphasizing the need for IT alignment in healthcare.

In the following chapter e-health as an IT innovation in healthcare is explored, and the theoretical frameworks on e-health are presented, concluding with the evaluation of main barriers in adoption and diffusion of e-health, with a focus on intangible benefits in the investment decision-making process.

CHAPTER 3

E-health As IT Innovation

"Nice! Nice to see innovation, it's nice to see new processes emerging, to gain new experiences, to discover things.
That is something that really appeals to me.
The creativity, which you encounter in innovation.
Making new things possible.
Which also leads to the improvement of the healthcare, and sometimes, that can be extremely gratifying."

Head of IT (and MD), top-clinical hospital (subject 5)

Health innovations generally diffuse slowly and have greater diffusion difficulties, even though there is no doubt that about the benefits of the innovation if it were adopted. Rogers states (p. 388): (2001) "One of the challenges for future diffusion research is to study innovations that would contribute to the public good, but that diffuse slowly."

This chapter defines e-health as an IT innovation in healthcare, and the theoretical frameworks on e-health are presented, concluding with the evaluation of main barriers in adoption and diffusion of e-health.

This emerging field in the intersection of medical informatics, public health, and business, referring to healthcare services and information delivered or enhanced through the Internet and related technologies, became known under the term 'e-health' in the late 90's, as a way of characterizing these technologies. The World Health Organisation (2006) proposed a compact definition of e-health: "the use of information and communication technologies for health".

3.1. E-health definitions

Innovative IT has introduced an alternative for the traditional face-to-face communication channel between healthcare professionals and their patients. For example; advances in technologies also serve the patients beyond the walls of the hospital in providing them access to their health records, such as laboratory results (Maheu, Whitten and Allen 2001), and in sustaining synchronous and asynchronous interactions with the medical professionals. For example, video-conferencing facilities have been successfully set-up for dietary and social services to the elderly (Swindell and Mayhew 1996). These technologies bring a certain idea of democratization to the patients, facilitating bi-directional channels of communication, supporting a new culture of communication that improves the quality of life of patients across geographical and cultural boundaries (Reid, Malinek, Stott and Evans 1996, Wilson 2003).

The emerging field in the intersection of medical informatics, public health, and business, referring to healthcare services and information delivered or enhanced through the Internet and related technologies, became known under the term ‘e-health’ in the late 90’s, as a way of characterizing these technologies, but also relating everything virtually to computers and medicine (Eysenbach 2001). During the evolution of e-health, new terminologies were developed as the applications and delivery options increased in variety, and the application areas expanded to almost all the fields medicine can cover (Bashshur, Shannon, Krupinski and Grigsby 2011, Lucas 2008). Broadly, e-health involves the use of advanced telecommunication technologies to exchange medical information allowing for the provision of healthcare services across geographic, temporal, social, and cultural barriers.

Oh, Rizo, Enkin and Jadad (2005) analysed the use of 51 e-health definitions, and the context in which definitions were applied. The widespread use of the term e-health suggests that it is an important concept, and that there is a tacit understanding of its meaning. Sood, Mbarika, Jugoo, Dookhy, Doarn, Prakash and Merell (2007) analysed the use of 104 e-health definitions, and the context in which definitions were applied. Through the years 1990-2006 the focus of the definition shifted from medical and technological aspects to benefits (improved access, enhanced efficiency and quality, enhanced distribution, and lowering costs).

In Table 3, a sub set of the definitions is presented that embrace a multi-level, or holistic (Nijland 2011) perspective on e-health:

Table 3: selection of multi-level definitions of e-health

Author	Definition
(Goldberg 1996)	Telemedicine involves the delivery of healthcare across a geographic separation by the use of telecommunications and computers. It has the potential to improve access to care for rural areas or areas underserved by healthcare specialists, improve access to medical education, and enhance the quality of care.
(Wootton, Craig and Patterson 1999)	Telemedicine is most commonly used to describe information and (tele) communication systems that are used in medical work, allowing people to work together over time and space.
(Paul, Pearlson and McDaniel Jr 1999)	Telemedicine, the use of IT to deliver healthcare from one location to another, has the potential to increase the quality and access to healthcare and to lower costs.
(Roine, Ohinmaa and Hailey 2001)	Telemedicine is the use of information and communications technology to provide healthcare services to individuals who are some distance from the healthcare provider. Rather than being a single technology, telemedicine is part of a wider process or chain of care. It has been assumed that telemedicine can improve this chain and thus enhance the quality and efficiency of healthcare. Telemedicine is also expected to increase the fairness and equality of the distribution of services as the accessibility of health services, especially in remote areas, improves.

(Eysenbach 2001)	Referring to health services and information delivered or enhanced through the Internet and related technologies; telemedicine is an emerging field in the intersection of medical informatics, public health, and business. In a broader sense, the term characterizes not only a technical development, but also "a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking to improve healthcare locally, regionally, and worldwide by using information and communication technology".
(World Health Organisation 2006)	e-health is the use of information and communication technologies for health.

The numerous definitions of e-health are, to some extent, are an indication of the concern that the practitioners and researchers have shown for this domain of high social relevance. These concerns lead to an understanding of important attributes of e-health (Tulu, et al. 2005). Thus, e-health:

(i) is a modality of healthcare delivery that has IT as one of its prime components, a media or channel for the exchange of healthcare related information;

(ii) uses, in nature and complexity, a broad scope of IT, bridging a distance;

(iii) depends on IT, which is the main reason for its continuous evolution;

(iv) is a complex concept that promises numerous benefits ranging from lowering of costs to improving access, quality, and efficiency of healthcare services.

Definition World health organisation

Researchers argue that e-health represents the promise of information and communication technologies to improve health and the health care system as a whole (Lin and Umoh 2002). The definition that the World Health Organisation (2006) proposes:

"e-health is the use of information and communication technologies for health."

With this definition, academia and practitioners can refrain from cumulating and discussing e-health definitions, leaving academia and practitioners room to focus on the realisation of the expectations of IT in the context of healthcare.

Era's of e-health

Tulu (2005) defines three eras of e-health:

(i) *Telecommunications era*: All the definitions during the first era of e-health focused on medical care as the only function of e-health. The first era can be named as the telecommunications era of the 1970s. E-health programs during the first era ended as the government terminated the funding before these programs matured. The applications in this era were dependent on broadcast and television technologies and e-health applications were not integrated with any other clinical data.

(ii) *Dedicated era*: This second era of e-health started during the late 1980s as a result of digitalization in telecommunications and it grew during the 1990s. The transmission of data was supported by various communication mediums ranging from analogue telephone lines to Integrated Service Digital Network (ISDN) lines.

The high investments involved with the communication mediums providing higher consumer bandwidth became an important bottleneck for e-health. This era has turned into an Internet era where more complex and ubiquitous networks are supporting e-health.

(iii)*Internet era*: The third era of e-health is supported by technology that is cheaper and accessible to an increasing user population. The enhanced speed and quality offered by the Internet is providing new opportunities in e-health. In this new era, the research strategies should include, an understanding of the functional relationships between e-health technology and the outcomes of cost, quality, and access that is beyond the assessment of technical sufficiency.

Types of e-health technology

Grigsby et al. (2002) group the range of home e-health services into either synchronous (real-time interaction) or asynchronous (interactive, but not real-time) categories.

Synchronous technologies include video and audio conferencing, whereas asynchronous or store-and-forward e-health includes technologies, such as e-mail.

Asynchronous systems may mediate such processes as the transmission of blood glucose data via modem, or the in-home monitoring of activities of daily living (ADLs) and instrumental ADLs. Full-motion video clips may also be used asynchronously (e.g., systems that permit video monitoring of frail or cognitively impaired individuals). Asynchronous e-health technologies also include the use of the Internet for exchanging health data and/or other information between providers and patients.

3.2. E-health frameworks

To rise to the challenge of adopting an IT innovation, an organisation must form expectations for the future that reduce the perceived uncertainty associated with planning, innovation decision-making, and action. Such expectations become part and parcel of a conceptual framework (Clark 1985), a sensible image (Tushman and Romanelli 1985) of the innovation that says what it is good for, how it works, under what conditions its benefits might be realized, the organisational changes it portends, and how it should be implemented. Building a credible, and useful conceptual framework imposes a demanding learning problem on prospective adopters who confront basic uncertainties concerning requirements, design, and use (Attewell 1994, Van de Ven 1993).

A range of analytical frameworks has been applied to the adoption and diffusion of e-health to analyse the broader social, institutional, and technological design issues involved in e-health adoption and diffusion.

Bashshur (1975) proposed one of the early comprehensive models for the systematic evaluation of e-health, which is based on a three dimensional matrix consisting of health delivery components (process, content, outcome, cost, and acceptance) and structural components (communication medium, provider mix, organisational form, and service population). Each of these components is assessed from three perspectives: the clients, the providers, and the overall system of healthcare.

Kwon and Zmud's (1987) framework proposes five contextual factors (user community characteristics, organisational characteristics, technology characteristics, task characteristics, and environmental factors), each of which may impact the six stages of IT implementation: initiation, adoption, adaptation, acceptance, routine and infusion. Kwon and Zmud extend theory to more complicated adoption scenarios, including adoptions of innovation by individuals subject to strong managerial influences. The contextual factors in the framework of Kwon and Zmud are closely related to Scott Mortons (1991) "Diamond" (MIT) model presented in Chapter 2. The framework of Kwon and Zmud (1987) has been applied successfully in the health care literature, according to Chau and Hu (2004).

A more detailed framework, also approaching the problem from the school of technology assessment, is proposed by Ohinmaa et al. (1999). Similar to other authors, they propose beginning with the technical assessment, followed by studies of effectiveness, costs, and patient and provider assessment of the usefulness of, usability of, and satisfaction with, the technology.

Yawn (2000) suggests an alternative framework for evaluation based on the clinical tasks that a physician or other health care provider must carry out to assess, treat, and follow patients. These tasks, which are employed in the care of most conditions, include visual tasks, auditory tasks, and instrumentation and palpation tasks. For each clinical task, the technology requirements for tools and settings are first established. The scope and limitation of the tools for those tasks are identified, and the need for integration with face-to-face care is assessed. The outcomes of the interaction of tasks, tools, and settings are assessed across broad categories of tasks, rather for than a single disease or condition.

Grigsby et al. (2002) developed a taxonomy of e-health applications for assessing the outcomes and costs of home e-health and to clarify the processes in care delivery to serve as a rational basis for fair and equitable reimbursement schemes. Although the taxonomy was intended to cover various uses of e-health technology in a residential setting, it can be applied to non-residential applications, such as telerobotic laparoscopic surgery. Given the nature of e-health, its evaluation requires careful specification of both input and output variables.

Rogers' theory (1983, 2003) is both comprehensive and specific. It provides a framework for analysis of the diffusion of innovations at a complex systems level, taking into account the differences in users, rate of adoption, types of information and decisions, and communication channels, while simultaneously facilitating identification of highly specific attributes of an innovation that affect diffusion.

Bernstein, McCreless, and Cote (2007), found five constants that routinely influence the successful integration of IT in healthcare. These constants are the proper use and maintenance of the IT budget, the role of supportive leadership, the use of project management, the process of implementation, and the significance of end user involvement. These constants challenge healthcare organisations to efficiently and effectively use their financial and human resources when adopting new IT.

Tulu et al. (2005) (2007) present a taxonomy that systematically classifies various e-health efforts worldwide using five major dimensions: application purpose, application area, environmental setting, communication infrastructure, and delivery options.

In Table 4 the previously mentioned frameworks are summarized:

Table 4: e-health frameworks proposed in literature

Author	Framework
(Bashshur 1975)	Three dimensional framework consisting of health delivery components (process, content, outcome, cost, and acceptance) and structural components (communication medium, provider mix, organisational form, and service population). Each of these components is assessed from three perspectives: the clients, providers, and overall system of care.
(Kwon and Zmud 1987)	A framework proposing five contextual factors (user community characteristic, organisational characteristic, technology characteristic, task characteristic, and environmental factors), each of which may impact the six stages of IT implementation: initiation, adoption, adaptation, acceptance, routine and infusion.
(Tanriverdi and Iacono 1998)	In addition to technical knowledge barriers, there are economic, organisational, and behavioural knowledge barriers that inhibit diffusion. Transaction cost economics, which examines exchange relationships between health care producers (providers, administration, and others), has been used to demonstrate how e-health shifts costs and changes relationships between entities.
(Ohinmaa, et al. 1999)	A conceptual framework beginning with technical assessment, followed by studies of effectiveness, costs, and patient and provider assessment of the usefulness of, usability of, and satisfaction with the technology.
(Yawn 2000)	A conceptual framework for evaluation based on the clinical tasks that a physician or other health care provider must do to assess, treat, and follow patients. A broadly oriented telemedicine assessment would allow a single evaluation of telemedicine for a proposed task and decrease the need to evaluate each new program or new use of telemedicine technology.
(Grigsby, et al. 2002)	Given the nature of e-health, evaluation requires careful specification of both input and output variables. The input variables include: configurations of technology, clinical or other health applications, organisational structures and human resources. The units of output consist of encounters that may be conducted live involving both patient and provider or provider and provider interacting in real time or in a “delayed” store-and-forward asynchronous fashion.

(Rogers 1983, Rogers 2003)	A framework for analysis of the diffusion of innovations at a complex systems level, taking into account the differences in users, rate of adoption, types of information and decisions, and communication channels, while simultaneously facilitating identification of highly specific attributes of an innovation that affect diffusion.
(Bernstein, et al. 2007)	Five constants that routinely influence the successful integration of IT in healthcare. These constants are the proper use and maintenance of the IT budget, the role of supportive leadership, the use of project management, the process of implementation, and the significance of end user involvement.
(Tulu, et al. 2007)	A framework that systematically classifies various telemedicine efforts worldwide using five major dimensions: application purpose, application area, environmental setting, communication infrastructure, and delivery options.

A basic description of the healthcare outcome process by Donabedian and Fund (1973) consists of two sets of behaviours that converge to produce outcomes (see Figure 8).

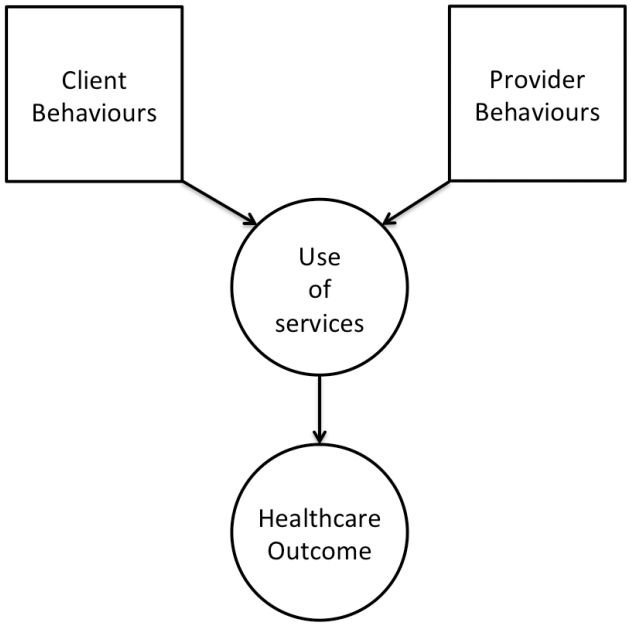


Figure 8: Donabedian healthcare outcome model

Client behaviours consist essentially of recognizing the need for medical care and the assumption of the sick role, whereas provider behaviours consist of conducting the diagnostic process and making decisions about treatment, therapy, and follow up. Use of service is the convergence of the two sets of behaviours, which, in turn, produces specified outcomes.

In addition to laying out the components of the process leading to healthcare outcome, one of the features of this model is the importance of the client in outcome attribution. Indeed, health outcomes, and the health of the population in general, cannot be solely attributed to medical intervention. Instead, health outcomes also reflects the effects of individual life style, assumption of the sick role on the part of the patient (such as recognition of symptoms, seeking care, and compliance with medical regimen), biological inheritance, and environmental factors.

3.3. E-health main barriers in adoption and diffusion

Despite its potential to lower costs and improve access to healthcare services, technical, economic, organisational, legal and behavioural knowledge barriers inhibit adoption and diffusion of e-health (Protti, Johansen and Perez-Torres 2009).

According to Tanriverdi and Iacono (1998), three metaphors that predominant in the innovation diffusion: Tanriverdi and Iacono (1998) extend Attewell's theory (1994) of knowledge barriers. In addition to technical knowledge barriers, there are economic, organisational, and behavioural knowledge barriers that inhibit diffusion.

Transaction cost economics, which examines exchange relationships between health care producers (providers, administration, and others), has been used to demonstrate how e-health shifts costs and changes relationships between entities. It has been used as a conceptual framework to analyse barriers to the diffusion of e-health:

(i) Communication and influence. The communication metaphor conceptualizes diffusion as a process where prior and potential adopters exchange signalling information about potential advantages of an IT innovation. Its main focus is on the adoption decision-making process. It suggests that adoption and diffusion patterns are associated with patterns of dissemination of signalling information among a target population.

(ii) Knowledge barriers and learning. Attewell (1994) proposes the knowledge barrier metaphor to address these limitations. It can be characterized as a learning process where potential adopters to acquire the technical know-how, associated with the use of IT innovations. The difficulty of learning such know-how constitutes knowledge barriers to adoption and diffusion of IT innovations. Attewell argues that adoption and diffusion of IT innovations is deferred until mediating institutions emerge in the market to help adopters acquire technical know-how.

(iii) Economic costs and benefits. The economic metaphor conceptualizes diffusion in terms of cost and perceived benefits of IT innovations.

Grigsby et al. (2002) identified factors that may inhibit adoption and diffusion of e-health. These include economic, social, organisational, and psychological issues.

Bashshur (2001) defines conditions needed for e-health adoption and diffusion and so indirectly identifies the main barriers:

(i) Access: Enhanced access to healthcare via e-health will be achieved only with the ubiquitous distribution of e-health.

(ii) Large scale: e-health potential contribution to increase quality of care can be realized only through large-scale diffusion of, and conversion to, e-health.

(iii) Large investments: E-health will not realise its full potential regionally, nationally, and internationally without greater investment in IT.

(iv) Substitution: the key to cost containment is effective substitution of e-health for traditional and more costly arrangements.

Similar findings were reported by other authors (Helfrich, Weiner, McKinney and Minasian 2007, Schrijvers, Oudendijk and de Vries 2003).

Grigsby et al. (2002) add three levels of scope to the Tanriverdi (Tanriverdi and Iacono 1999) metaphors:

(i) The societal level: In health care systems and government policy, it is customary to attribute what appears to be a slow adoption and diffusion of e-health to societal barriers such as: the lack of a widely accepted coverage and payment policy, restrictive interstate licensure issues, inadequate human factors design, lack of uniform engineering standards, and concerns over confidentiality, security, and liability.

These commonly cited barriers operate primarily at a broader level than individual institutions or providers, and hence they affect most providers in similar ways.

(ii) The institutional level: In health care organisations Bashshur (1975, 1995, 2001) and Bashshur et al. (2005) addressed the diffusion of e-health, noting "when technological innovations are not accepted or implemented properly, generally the failure may be traced to a poor alignment between the nature of the innovation and the interests, resources, and expectations of its major stakeholders.

(iii) The role of government: The role of government in influencing the pace of telemedicine diffusion varies considerably, at least in relation to the type of health care system. The government has an interest in ensuring access to quality health care at a reasonable cost, but it is also interested in controlling costs and controlling the spread of technologies that might increase costs. To influence the development and future direction of a technology, governments must establish policy early. Unfortunately, this is typically at a time when the intangible benefits cannot be predicted yet.

Grigsby also argues numerous factors that inhibit adoption and diffusion of e-health, including economic, social, organisational, and psychological issues.

Rogers' theory (1983, 2003) can aid in identifying barriers to the diffusion process and relating them to a larger body of research on effective practices and conditions to facilitate diffusion. These elements, in summary, are: attributes, social system, time, type of decision, and communication network.

Attributes

(i) Relative advantage: the degree to which an innovation is perceived as better than the innovation it replaces.

(ii) Compatibility: the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters.

(iii) Complexity: the degree to which an innovation is perceived as difficult to understand and use.

(iv) Trialability: the degree to which an innovation may be experimented with on a limited basis.

(v) Observability: the degree to which the results of an innovation are visible to others.

Social system

(i) Change agent: individuals who influence innovation-decisions in a direction deemed desirable by a change agency. The change agent usually seeks to obtain the adoption of new ideas, but may also attempt to slow down diffusion and prevent the adoption of undesirable innovations.

(ii) Opinion leader: opinion leaders are able to influence other individuals' attitudes or overt behaviour informally in a desired way with relative frequency. This informal leadership is not a function of the individual's formal position or status in the system. Opinion leaders occupy unique and influential positions in the system's communication structure, that is, they are at the centre of interpersonal communication networks.

Time

(i) Critical Mass: a minimal level of adoption must also be achieved to allow more rapid adoption and diffusion into a population of potential users.

(ii) Stages of the innovation decision making process: the diffusion-innovation process is a series of stages—knowledge (initiation), persuasion, decision, implementation, and confirmation—that adopters go through to decide to adopt the technology.

Type of decision

(i) Authority decisions: decisions made by a relatively few individuals in a system who possess power, status, or technical expertise;

(ii) Optional innovation decisions (individual): decisions made by an individual independent of the decisions of the other members of the system;

(iii) Collective or organisational decisions: decisions made by consensus among members of the organisation;

(iv) Contingent innovation decisions: a sequential decision process requiring two or more of the above types of decisions.

Communication network

Communication is the process by which participants create and share information with one another in order to reach a mutual understanding. Diffusion is a particular type of communication in which the information that is exchanged is concerned with new ideas.

The essence of the diffusion process is the information exchange by which one individual communicates a new idea to one or several others. A communication channel is the means by which messages get from one individual to another.

3.4. E-health investment decision-making process and intangible benefits

Bashur et al. (2005) point out that despite several decades of growth and deployment of e-health programs, the majority of evaluation studies does not rise to the level of producing definitive results on the benefits and costs of this field. Hence, claims of e-health program efficacy pertaining to improved access, equal or enhanced quality compared with traditional medical care, and reduced costs cannot be made with strong assurance. The reasons for this problem are many, including:

(i) A failure to use a precise and uniform definition of "e-health," and the multidimensionality of the innovation bundle of e-health.

(ii) The continuous improvement of the underlying technology of e-health, and the expansion of applications.

(iii) Experimental problems, such as: lack of clarity in specifying the experimental variables; difficulty of experimental allocation and blinding and jumping experimental allocation; limited fidelity in program implementation, inadequate program maturity, and steady-state operation; multiplicity of program affects, delayed effects, and unintended effects; and lack of large-scale programs that would permit experimental studies.

(iv) Insufficient funding for large-scale experimental studies.

(v) Failure to exploit the full potential of e-health.

Williams, May and Esmal (2001) reviewed 93 empirical studies that investigated patient satisfaction with e-health service. Aspects of patient satisfaction most commonly assessed were: professional-patient interaction, the patient's feeling about the consultation, and technical aspects of the consultation. Only 33% of the studies included a measure of preference between e-health and traditional face-to-face consultation. Almost half the studies measured only one or two dimensions of satisfaction. Progression of e-health services from "trial" status to routine health service must be supported by improved research into patients' satisfaction. Reported levels of satisfaction with e-health were consistently greater than 80%, and frequently reported at 100%.

As yet, the net benefits have not filtered through to other stakeholders in the health care system, such as physicians, pharmaceutical companies, and society at large. By understanding how patients use communities, health care providers will see the need to cultivate them for improved quality of the patient's health care experience, with minimum investment on their part in order to better promote patient well-being. This has larger social and economic benefits for the entire health care system (Johnson and Ambrose 2006). The most successful communities are believed to be those that develop systems, business models, workflow, and institutional support for e-health (Tanriverdi and Iacono 1998). However, there is a balance between the excitement and infinite possibilities of e-health with real-world considerations and broader efforts in health IT (Curry 2007).

Jennett, Affleck Hall, Hailey, Ohinmaa, Anderson, Thomas, Young, Lorenzetti and Scott (2003) argue that e-health studies to-date have not used socio-economic indicators consistently.

However, specific e-health applications have been shown to offer significant socio-economic benefit to patients and families, health-care providers, and the health-care system. The main benefits the authors identified are: increased access to health services, cost-effectiveness, enhanced educational opportunities, improved health outcomes, better quality of care, better quality of life, and enhanced social support. Although the review found a number of areas of socio-economic benefits, there is the continuing problem of limited generalizability.

Herbert (2001) argues that one measure of "success" in health care is quality patient care, and that this reflects a primary reason for IT investments. Herbert addresses the concern of the generalizability of findings; recent studies have given inadequate attention to defining what is done (i.e., comparison of e-health to most appropriate alternative), as well as to identifying the beneficiaries of e-health and what is measured.

According to Wright (1999), there are potential advantages and benefits from e-health, but the evidence of its cost-effectiveness and sustainability is meagre. Phillips, Vesmarovich, Hauber, Wiggers and Egner (2001) report that the General Accounting Office notes that while federal agencies in the US spent $646 million on e-health projects from 1994 to 1996, rigorous evaluations of the cost and benefits are lacking. A key challenge is to demonstrate that e-health interventions can substitute for traditional care, or that the addition of e-health leads to future cost savings.

E-health undoubtedly yields cost savings in certain circumstances, but few service providers have found a way to recover their investments (and make a profit) from those to whom they provide their service.

There is even a hazard of increasing the average task completion time per patient encounter by introducing IT (Ash, Berg and Coiera 2004), such as electronic patient records leading to a negative total net savings, undermining the economic justification.

Ohinmaa et al. (1999) point out the difficulties in conducting cost-effectiveness or cost-utility analysis of e-health, including rapidly changing technology, decreasing costs, and other factors.

Bates (2002) observes few studies that have examined IT investment and quality, suggesting that benefits can be demonstrated for specific applications and domains. However, many benefits will take time to be realized, and may accrue across a sufficiently broad range of areas that it will be hard to attribute them directly to changes in IT.

Brebner, Brebner and Ruddick-Bracken (2005) report that many e-health projects fail to survive beyond the funded research phase. The main reasons associated with partial failure are: the service was not needs-driven, no commitment to provide the service, no suitable exit strategy after research funding expired, poor communication, a lack of training, technical problems, work practices not updated, and poor or non-existent protocols for use.

Bashshur, Shannon and Sapci (2005) argue that there is no good evidence that e-health is, or is not, a cost effective means of delivering health care. Any economic assessment that takes capital cost into account but does not incorporate sensitivity analysis under various assumptions of resource capacity, utilization volume, and level of maturation, learning curve, or steady-state operation is likely to underestimate the potential return on investment.

Because capital cost is fixed, it is obvious that the more frequently and the more efficiently the program is used, the more favourable will be the return on investment. But even this argument may have flaws. Scale is important, and some minimal level of investment and operational size may be necessary to establish a viable program. Moreover, given conditions of under-use, the logical question continues to be whether simpler and lower-cost technology (essentially, lower investment) could be more fully, and therefore, more cost-effectively, used. Bashur et al. (2005) reiterate critics' concern that e-health may produce adverse effects by decreasing accessibility by displacing rural providers). Also increasing total cost by unleashing consumer spent-up demand and potential provider- induced demand). And compromising quality by relying on a technology that may be a poor substitute for in-person care.

Hailey et al. (2004) report on e-health financial cost-benefit models. The challenge is in identifying the potential cost and benefit of e-health. There are several methods of analysis:

(i) Cost-minimization analysis – compares cost between various strategies. A cost-minimization analysis is valid only if other factors, such as clinical effectiveness, can be assumed to be similar.

(ii) Cost-effectiveness analysis – reports outcomes in non-monetary, typically in clinical terms (e.g., quality adjusted life years, outcomes of blood pressure).

(iii) Cost-benefit – the concept of value and profit can have many meanings: benefits compared to cost.

(iv) Cost-utility – focuses on the costs of the functions that facilitate healthcare objectives, such as providing medical services or improved access to care. These intangible benefits do not have to be expressed in monetary terms.

Reardon (2005) addresses the challenge that lies in distinguishing inputs and outputs, and assigning appropriate costs and benefits where they are tied to the subjective assessments of the decision maker.

Brynjolfsson and Hitt (1996) acknowledge it is difficult to identify intangible benefits of IT investments, such as improvements in quality. E-health may create new outcomes of care or change outputs or outcomes. These benefits of e-health are often difficult to identify, partly because detecting them depends on our expectations or knowledge of effects on health or other outcomes. Also, detecting benefits may depend on timing, with some benefits only becoming apparent at a time in the future. Then again, whether an outcome is a benefit may depend on the perspective of the decision maker or stakeholder. The decision maker may be interested in the ability of e-health to provide visits or treat episodes of care, but not interested in the longer-term effects on health. But even with outcomes identified, assigning value to the outcomes of e-health and aggregating the sum of benefits for all outcomes remains difficult.

Clemons (1991) argues that the increasing competitive impact of, IT makes the IT innovation decision-making process challenging for management.

Traditional methods, such as Net Present Value (NPV) are directed toward economic precision. When decision makers cannot precisely estimate benefits accurately, often the value of intangible benefits are set to a zero value. However, it may be possible to estimate them with enough accuracy to rank alternatives. Not the decision's NPV in absolute terms but a NPV that is superior to (less negative than) the alternatives.

When an IT innovation can involve a substantial additional investment, it is increasingly difficult to justify the negative NPV. Clemons identifies this mechanism as ‘the trap of the negative net present value’.

Sometimes a sensitivity analysis of alternatives can capture uncertainty. Not continuing the status quo while a competitor will choose to implement an innovative information technology. The alternative is to face a deteriorating competitive position resulting in loss of market share and eventually reduced margins. Clemons identifies this mechanism as 'the trap of the vanishing status quo'.

Serafeimidis and Smithson (2003) therefore promote increased the awareness regarding the business contribution of IT, and to promote a richer evaluation culture including the consideration of intagible benefits and the associated risks. Buccoliero (2008) also identifies intangible corporate benefits and social benefits as dimensions of the e-health investment process.

The intangible benefits created by IT innovations is becoming increasingly important. Thus, while traditional research has focused on direct economic benefits Kohli and Grover (2008) suggest that economic value must be expanded to include indirect and intangible benefits, such as agility, flexibility, and first-to-market. Economic endogenous impact should include variables where the economic impact in the external marketplace is evident. Characteristics such as flexibility, agility, and customer service would meet the criteria, while endogenous variables that focus on internal characteristics of the firm such as quality of employee life or user satisfaction may not. By broadening the repertoire of economic variables, the authors advocate research that recognises the different types of economic impacts and perhaps their different antecedent variables.

Goldzweig, Towfigh, Maglione, and Shekelle (2009) report a paucity of meaningful data on the cost-benefit calculation of IT implementation in healthcare. Without a better alignment between "who pays" and "who benefits" from health IT adoption, we can expect it to proceed at an exceedingly slow pace. Decreasing the financial barriers and providing a more robust evidence base regarding health IT can be expected to greatly accelerate its adoption.

Few economic evaluations of e-health consider the full range of benefits, such as societal benefits. The societal benefit of e-health therefore remains therefore unknown, making it difficult for decision makers to make an informed decision as to which are worth implementing e-health from a societal perspective. To facilitate more advanced economic evaluations, Davalos, French, Burdick, and Simmons (2009) present research guidelines for conducting cost-benefit analyses of e-health programs, emphasizing opportunity cost estimation, commonly used program outcomes, and conversion factors to translate outcomes to monetary terms.

3.5. Summary

In this chapter the literature for the theoretical frameworks on e-health as an IT innovation in healthcare is explored, and the theoretical frameworks on e-health are presented, concluding with the evaluation of main barriers in adoption and diffusion of e-health, with a focus on intangible benefits in the IT innovation investment decision-making process.

A selection of frameworks is presented in Table 5. These frameworks form are used in the analysis of the case study presented in the following chapter.

Table 5: Frameworks used for case study analysis

Framework	Reference	Use of the framework for case study analysis
Innovation dimensions	(Tulu, et al. 2005, Tulu, et al. 2007)	Classification of innovation dimensions
Elements of adoption and diffusion of innovations	(Rogers 1983, Rogers 2003)	Classification of innovation dimensions and map the stages in the innovation decision making process
Metaphors of adoption and diffusion	(Tanriverdi and Iacono 1998)	Map the innovation decision making process
Contextual factors of adoption and diffusion	(Kwon and Zmud 1987)	Map the innovation decision making process context

CHAPTER 4

Case Study Analysis

"For us Telebaby has been very important. Our oldest daughter (1.5 years) could not be with her new-born sister because of her age and the fact that she has a disease herself. Thanks to Telebaby she could be with her sister every day."

Parents using the VBVS, University hospital

This chapter generates in-depth insight into the adoption and diffusion of an IT innovation in healthcare presented in a longitudinal case study analysis of a specific e-health application Virtual Baby Visit System (VBVS) in two hospitals in the Netherlands. The case study is analysed along the selected frameworks presented in the previous chapter describing the stages of the innovation-decision process: the first knowledge (initiation) of an innovation, towards forming an attitude toward the innovation, the decision to adopt or reject, the implementation of the innovation, and the confirmation of the decision.

4.1. Case study description

This case study describes in detail the implementation of the VBVS. The VBVS is an Internet based facility providing a live video stream that connects parents to their hospitalised new-born.

The case study includes two hospitals in the Netherlands (see Figure 9 and Table 6) that implemented the VBVS at different periods in time:

- The University Medical Centre Utrecht is an university hospital, the first in the Netherlands to implement the VBVS; (1999 Telebaby CCTV) 2000 Telebaby Internet;
- The Catharina Hospital Eindhoven is a top-clinical hospital, and the first in the world to implement a mobile version of the VBVS; (2003 BabyOnline) 2007 BabyMobile;

Figure 9: Left; University Medical Centre Utrecht,

and Right; Catharina Hospital Eindhoven

Table 6: virtual baby visit system case study characteristics

Dimensions (Tulu, et al. 2005, Tulu, et al. 2007)	Case	
	Telebaby Internet	**BabyMobile**
Application purpose	To provide live video images from newborn to parents and relatives	To provide live video images from newborn to parents and relatives
Media attention (see Appendix C)	First in the Netherlands Internet video streaming	First in the world using 3G video streaming
Phases of technology (see Figure 10, 14 and Appendix A)	Analogue and IP camera's CCTV and Internet	IP camera's Internet and 3G mobile devices
E-health era	Dedicated, Internet	Internet
Hospital type Period Hospital budget and employees	University 2000 – now 600 million Euro, 6,700 full-time equivalent (fte)	Top-clinical 2003 – now 215 million Euro, 2,360 fte
Environmental setting: Hospital	350,000 ambulatory visits. 28,000 admissions, 240,000 nursing days, 16,000 short stay visits in 1,050 beds.	350,000 ambulatory visits, 25,000 admissions, 170,000 nursing days, 19,000 short stay visits in 699 beds.
Application area: Perinatal center	20 million Euro, 300-400 fte, 3 million Euro medical equipment. 40,000 ambulatory visits, 600 short stay days, 4,500 admissions, 2,500 adults and 2,000 newborns of which 1,000 Low Care, 500 Medium Care, 500 Intensive/High Care. 30,000 nursing days in 100 beds and cribs.	10 million Euro, 150-200 fte, 1 million Euro 40,000 ambulatory visits, 1,500 short stay, 4.800 admissions, 3,150 adults and 1,300 newborns most of which Low or Medium Care. 20,000 nursing days in 80 beds and cribs.
Cost[2]	75,000 Euro Telebaby CCTV (50,000 Euro) Telebaby Internet (25,000 Euro)	35,000 Euro BabyOnline (25,000 Euro) BabyMobile (10,000 Euro)

[2] Cost = total cost of ownership over three years, including depreciation of cameras, exclusive internal cost such as information technology department, general internal network facilities, external bandwidth.

Figure 10: Top; Telebaby (2001, family Krol) Internet University Medical Centre Utrecht and Bottom; BabyMobile (2007, family Berbers) Catharina Hospital Eindhoven

In Appendix A, a detailed overview of the VBVS and phases of technology is presented chronologically.

To categorize the chronologic sequence of events, the five stages of Roger's (2003) theory on innovation decision-making process presented in Chapter 3 are used as a guideline: knowledge (initiation), persuasion, decision, implementation, and confirmation.

4.1.1. Case study 1: UMC-Utrecht Telebaby

The following section describes a chronological sequence of events at University Medical Centre (UMC) – Utrecht:

1. Initiation of Telebaby

In 1999 the new building for the children's hospital in Utrecht, the Netherlands, was opened. In the new building, neonatology and obstetric care were located in one building, forming a perinatal centre. This was based on the vision of the healthcare professionals, namely, that quality of perinatal care can gain from keeping mother and child as close together as possible.

Although similar systems were already operational in several hospitals in the Netherlands, there was no known research on adaption and implementation of a Closed Circuit TV systems (CCTV) in perinatal centres. In the new hospital building an analogue CCTV using coax cable was set up to allow mothers to view their new-born from their bed. Adoption amongst healthcare professionals and parents was uneventful.

The system was confined to the safe walls of the hospital, and there was a point-to-point connection between the camera and the TV above the mother's bed. The CCTV system was supported financially by a foundation related to the children's hospital, with 50,000 Euro laying the foundation for Telebaby.

2. Forming an attitude towards Telebaby

The healthcare professionals experienced a discontinuity of care discharging the mother and keeping the new-born in the hospital. A new, Internet based, VBVS, based on the camera infrastructure of the CCTV system, had the potential to solve this issue.

Learning from a broadcast company how to do this (Dutch TV-broadcast company VPRO) using low cost of the shelf technology (personal computers running Microsoft Windows and Osprey codec cards and RealServer and RealPlayer), the department manager and IT-employees succeeded in a technical proof of concept. The patch bay of the CCTV system allowed a centralised approach to digitalise and stream the video using online real-time codec hardware. This proof of concept was created with a minimal budget (1,000 Euro). Based on this proof of concept, enthusiasm grew.

Enthusiasm was further spurred by a stakeholder session using GroupsSystems in which healthcare professionals (nurses and physicians), the IT department, and top-management discussed traditional (face-to-face) communication versus communication using innovative IT (N=20, split into two sessions, video recorded and facilitated by GroupsSystems: five physicians, five nurses, five IT department, and five members of top management). The main conclusion was that communication using innovative IT cannot replace traditional (face-to-face) communication. Communication using innovative IT is seen as additional.

3. A decision to adopt or reject Telebaby

At that point, an IT vendor (Infoland) seeking its way into healthcare was interested to rebuild the technical proof of concept in a more user friendly model (actually it had already built a framework for video streaming) for the price of 25,000 Euro, including hardware. Most of this investment was supported financially by a foundation related to the children's hospital.

It took some effort to convince the central IT department of the hospital to co-operate. From a security perspective, there was some hesitation to open the necessary IP ports that would allow video streaming. At that time, the UMC had both a hospital and a University IT policy. The University IT policy was more 'open,' since it had to support the spread of information between researchers in and outside the organisation. Eventually, a political solution was found. The video streams would pass via a University V-LAN so that it could be separated from the regular hospital IT.

4. Implementation of Telebaby

The software and operating system were accessible through a standard browser via the hospital's website. The login screen had a disclaimer page covering legal issues.

The administrator had access to all menus including:

(i) system users menu where types of users could be set and with the camera control menu that controlled the IP settings of the streams, and

(ii) general fields menu where the patient data fields along with the stream could be displayed.

The IT department and nurses had access to the patient menu, where streams were assigned to patients and where pre-defined patient data fields were filled in.

The parents' menu displayed the stream of their new-born and some data fields, such as the telephone number of the unit and the name of the assigned nurse.

Besides technological barriers, organisational barriers also had to be taken. Nurses were used to the camera on the unit, but the fact that the video would be distributed over the Internet made them cautious.

Privacy was mainly an issue for the adoption of the system by healthcare professionals, especially when they appeared on camera inadvertently when taking care of a baby admitted in the next crib. Being 'monitored' while caring for the patient raised questions on 'What if I make a mistake?' The issue was solved in a dialogue amongst healthcare professionals: the quality of work should not differ on- or off line. Also, it was already allowed for parents to record their new-born on video under certain conditions. On the parents' side, there were ample concerns regarding security and privacy. The need to see and show their child on-line was so high that they accepted challenging experimental technology.

Healthcare professionals were provided the full right of switching off the cameras at any time without justification, i.e., when giving care to the new-borns for medical and ethical purposes. This was carefully communicated to parents. A disconnected system was evident by a black screen indicating a faulty camera; a blue screen indicated that the system was operational, but the camera was switched off. The camera was able to be switched off at will.

To further assure privacy and not raise anxiety with false-alarm bells (although technically feasible), sound was not transmitted with the streams, and remote panning with the cameras was disabled. The camera was positioned in such a way that displays of medical equipment were not visible.

Healthcare professionals believed the new system would further increase their workload, which was the case, since new user accounts had to be set up. Clear manuals and low complex user interfaces supported this, and thus the additional workload was as minimal as possible. Healthcare professionals soon became familiar with requests from parents to readjust the camera. Previously, parents tended to call the unit when they reached home after a visit. With the new system they could create their own access, thus actually reducing the workload of healthcare professionals.

Parents had a hardcopy manual with step-by-step screenshots. The software also had an extensive manual that was accessible via the website. Although parents had a comprehensive manual, in the beginning there were issues with logging into the system. This was mainly caused by the fact that a proprietary plug-in had to be downloaded and installed in Netscape (Internet Browser in 1999 with market dominance). Cunningly, a 'demonstration' account was activated where parents were shown how to login easily to this test account, and to 'test the connection' before their account was activated. Only after having successfully logged onto the demonstration stream, were parents given the login-name and password for their child. In this way the stress of logging onto their new-born was reduced until a working connection on the parent's side was established. The risk was thus reduced that family members would gather around a PC with their new Internet account, and fail to see the new-born.

The adoption of the system did not require the parents to be Internet experts. For those who did not have a personal computer, three pre-configured laptops, including an Internet account, were made available. They were scarcely used, as most parents saw the opportunity of seeing and showing their new-born online as a good reason to get a new computer with Internet access.

5. Confirmation of Telebaby

The VBVS was officially released under the name Telebaby in 2000, but had functioned in an experimental stage in 1999. It had national media attention and was one of the first systems in place in the world in a complex environment of neonatal intensive care. The hospital used the publicity to support their award winning (2000, see Figure 11) national corporate campaign on innovation under the name, Big Mother, after the popular TV reality program (live video streaming). Big Brother, where people living together in a specially prepared house were followed by cameras for 100 days. Big Brother obviously referred to George Orwell's novel 1984.

Figure 11: Big Mother, UMC Utrecht's successful corporate campaign on innovation "We will always innovate"

Acceptance of the VBVS was measured using data gathered from the answers of parents to a short questionnaire (see Appendix B) and interviews with the healthcare professionals. It demonstrated that the VBVS was well accepted.

A mother declared: “I found it hard to get discharged from the hospital after giving birth because I could not be with my daughter the entire day. I was relieved that I could be with her through the Internet.” Both parents used the system in most conditions (81.5%) and were enthusiastic about the possibility of using Telebaby complementary to their regular visits at the hospital: “I think Telebaby is a fantastic idea, I could only visit the hospital once a day, this way I could see my new-born all day, and that was great.” The majority of them used the system daily (85%) and some fathers also used the system from their work place (19%). Seeing their baby seconds after logging in is crucial for parents (77%). Only 18.5% faced a blue screen (indicating the camera was switched off) after the login phase: “We were not anxious to see the blue screen. We knew that the nurses were taking care of our baby and we respected their decision to switch off the camera.” (Spanjers and Rutkowski 2003)

More than one viewer could access the streams at one time. Parents were free to pass on the login name and password. The majority of the parents of the hospitalised baby shared their login with other family members, especially with sisters and brothers (56%), with grandparents (48%), as well as best friends (33%), and work colleagues (22%). The monitoring of the login behaviour of the parents confirmed that fact. One family had about 40 different users. Another family extended the login information to relatives in Brazil. Worldwide communication was established in the whole family and produced a feeling of closeness amongst the concerned family members. One family wrote “For us Telebaby has been very important. Our oldest daughter (1.5 years) could not be with her new-born sister because of her age and the fact that she has a disease herself.

Thanks to Telebaby she could be with her sister every day." The VBVS reduced the anxiety-state of the parents and, overall, added communication possibilities in difficult family circumstances. The system gave them a feeling of greater control on their relationship with their baby. (Spanjers and Rutkowski 2003)

The results of a single-item questionnaire (see Appendix B) on a 5-point scale (Strongly Agree to Strongly Disagree) indicated that the system principally lowered the state of anxiety associated with parent-child separation, and was not primarily used by the majority of the parents to check-upon the quality of care provided to their child. 100% of the parents declared that the system enabled them to virtually see their new-born; which was important them. 78% of the parents declared that the system helped them to feel much less worried.

Actual use of the VBVS increased their trust in it and general acculturation. Parents were provided with adequate psychological support by the medical personnel adjacent to the system. Only 23% reported some difficulty when logging off the system; however, stopping the connection was not associated with a negative emotion. 'Live' visits were always first choice; that is, the system was meant to be an additive support to bonding, not a substitute. Overall, parents were very satisfied with the benefit of the system and concluded VBVS "is a fantastic project." (Spanjers and Rutkowski 2003)

Telebaby had national media attention and was one of the first systems in place in the world in a complex environment of neonatal intensive care. Details of media coverage can be found in Appendix C. The hospital used the publicity to support their award winning (2000, see Figure 11) national corporate campaign on innovation under the name, "Big Mother", after the popular TV reality program (live video streaming) and so contributing to the confirmation phase of the innovation decision-making process.

Research on the adoption of the VBVS system was published in 2002 and further (Spanjers and Feuth 2002a, Spanjers and Feuth 2002b, Spanjers and Rutkowski 2003, Spanjers and Rutkowski 2005b); encouraging other hospitals to adopt similar technology. UMC Utrecht, being the largest and most modern perinatal centre in the Netherlands, played an important role as a reference to other hospitals.

The VBVS had one mayor hardware update after five years, replacing the hardware by newer machines which functioned until 2009; it was then replaced with a VBVS based IP cameras (Baby Mobile Cameramanager.com), similar to the VBVS implemented in Catharina Hospital.

4.1.2. Case study 2: Catharina Hospital BabyMobile

The following paragraph describes the chronological sequence of events at Catharina Hospital.

1. Initiation of BabyMobile

The perinatal care of the Catharina Hospital is relatively smaller and lower in complexity than that at UMC-Utrecht; the average duration of stay of new-borns is significantly shorter than a setting providing respiratory therapy and intensive care. The department management and healthcare professionals were very interested in the possibilities of implementing a virtual baby system.

The manager of the division perinatology and gynaecology of the UMC Utrecht was appointed head of Finance and IT in Catharina Hospital in 2002. At that time, there were some VBVS in place in several early adopting hospitals in the Netherlands (see also Appendix E).

With the experience and support of their head Finance and IT, a copy of the system in UMC-Utrecht system was put in place in 2004 under the name: BabyOnline. Technically there was a difference. This system used IP cameras, thus avoiding the complicated step of on-line real time transforming analogue signals into digital signals. References from other hospitals and material such as manuals made the implementation process uneventful. It took less effort to convince the central IT department of the hospital to co-operate, although there was some hesitation in opening the necessary IP ports that would allow video streaming. Eventually, a solution was found by installing a separate firewall for the virtual baby visit system. In this way, the video streams could be separated from the main hospital infrastructure. The downside was that the nursing staff had a slightly more complicated task setting up a user account for parents. Fundraising for the system was made easier by the success of a previous implementation, and it also the reduced cost of such a system. A foundation supporting the hospital funded the 25,000 Euro to cover the complete project.

2. Forming an attitude towards BabyMobile

After two years the head of Finance and IT and a former UMC Utrecht employee now working in Catharina Hospital decided to take things one step further: establishing the virtual baby visit mobile. In this way, the discontinuity that parents experienced when not being near a PC could be solved.

At that time, there were no mobile devices that could stream video based Internet technology: the diffusion of 3G mobile networks was underway (400 bit maximum, average 100 bit connection, 75% coverage), and more and more phones had adequate quality of screens and processors to handle video streaming. Through a consultant specialized in mobile technology (Telecom4Care) in 2006, a suitable partner (Triple-IT) was found to set up a technical proof of concept, simply connecting one IP camera to a mobile using the public 3G net. At the end of 2006 Catharina hospital was the first hospital in the world that provided live video streaming from their neonatal ward on a mobile phone, the application of which was called BabyMobile. The hospital used this as an extension of their existing BabyOnline system, and only a limited number of phones were available. The first version of BabyMobile required parents to operate a dedicated mobile phone that they had not operated before.

3. A decision to adopt or reject BabyMobile

In 2007 the search for an integral solution was started. A small company operating in the niche of IP security cameras (Cameramanager.com) was willing to adapt their mobile portal to the requirements of BabyMobile. In 2008 the new system was put in place. But built on previous success, a large mobile network provider was prepared to support this with an additional 25,000 Euro and ten mobile phones plus accounts upon showing a technical proof of concept. Since high charges for mobile phone data transactions were expected, a large mobile network provider was approached for funding. At first they were hesitative, since hospitals had the image of lagging in implementing IT. Technologically, this was a major change. The streaming video distribution was no longer provided by the hospital but by an ASP provider.

All the cameras inside the hospital had only one connection, and that was to the video server of the ASP provider. The provider handled the distribution, and through a web application, healthcare professionals could monitor the video streams and add new accounts for parents.

4. Implementation of the new idea BabyMobile

Again, available was a hardcopy manual that was comprehensive in language use with step-by-step screenshots. Healthcare professionals could test the connection at the hospital with the parents before handing over the mobile phone.

Catharina Hospital is located in Eindhoven, and most of their patients came from the direct environment. 3G coverage was adequate. Some villages surrounding the city of Eindhoven did not have adequate 3G coverage, and the BabyMobile could not be used there thus parents had to revert to the traditional BabyOnline system.

5. Confirmation of BabyMobile

The official release of BabyMobile in the beginning of 2007 had national and international media attention (see Figure 12):

Figure 12: Press photo BabyMobile (photo: Brigitte Rijshouwer)

Research on the adoption of the VBVS system with mobile technology was published in 2006 and after (Rutkowski, et al. 2006, Spanjers and Rutkowski 2007, Spanjers, et al. 2007); encouraging other hospitals to adopt similar technology. Catharina Hospital, being one of the larger top-clinical hospitals in the Netherlands, played an important role in referring the system to other hospitals.

The official release of BabyMobile in the beginning of 2007 had national and international media attention (see Figure 12). Details of media coverage can be found in Appendix C.

Initially, the use of the BabyMobile was limited to dedicated phones, and obviously there was similar access via the Internet. This was to keep the instruction given by nurses as standard as possible. In 2010 the use of private patient phones was also allowed.

4.2. Comparing case studies VBVS

To find similarities and differences, the elements presented for the two case studies are combined and categorized.

1. Initiation of the VBVS

IT in healthcare sector is more and more seen an opportunity for nursing to use a new medium to meet the mission of our profession, not as something that is approached with trepidation and fear (Abbott and Coenen 2008).

Primary development of the organising vision takes place during the innovation's earliest diffusion. The hesitant Early Majority among the prospective adopters relies on this development in its efforts to make sense of the innovation.

Where the organising vision remains underdeveloped after early adoption, later diffusion and institutionalization of the innovation are likely to be slow. A key element in the adoption of VBVS was the policy of the perinatal centres in keeping mother and child as close as possible after birth, thus giving maximal access to the child by both parents. Leaving the security of the in utero nest and ending up in intensive care are drastic experiences for premature infants.

2. Forming an attitude towards the VBVS

Parents who leave a new-born baby at the hospital experience traumatic stress and enter into an anxiety-state when separated from their new-born. In paediatrics, healthcare professionals daily measure the effects of social deprivation on the new-born and their parents. Facilities such as rooming-inns and open visiting hours for parents can contribute in the reduction of social deprivation.

Providing an in-house closed camera circuit and later live video-streaming access through the Internet seemed a logical next step. It was already allowed for parents to record their new-born on video under certain conditions; the facility was just one step further. The system addressed the needs of the parents and indirectly affects the infant. A VBVS cannot replace the warm physical skin-to-skin contact of parents with their new-born, but this technology certainly precipitated more relaxed parents to the care unit.

The IT department progressively moved to the idea that crossing the walls of the hospital would bring valuable services to patients. Despite some resistance at an early stage in both cases, they also recognized that the system provided them with the opportunity to experience technologies less commonly used in hospitals.

Improvements in the IT progressively made the VBVS more accessible and flexible to users. Starting with a closed circuit camera system with point-to-point and an internal focus, the system evolved to an IP camera, Internet technology based system with mobile capabilities.

Understanding of nursing concerns is imperative when implementing IT innovations (Hsiao, Li, Chen and Ko 2009). Developing VBVS to address nursing concerns regarding training, privacy and litigation supported its adoption and implementation.

In both cases, the extra training provided for nurses facilitated the acceptance of the VBVS. They considered it to be an innovation, and advertised its benefit for parents to colleagues in other hospitals. After key-questions on privacy and litigation were answered by the successful implementation of the first generation of the system most nurses were 'for' using the system. Faced with an enthusiastic majority, the few lagging nurses still opposed to the system were soon convinced.

Since it is mostly nurses who regulate traditional visits, physicians typically regard the online baby system as being part of the nursing domain. Overall, physicians have been supportive and recognize that although it does not bring a direct contribution to their care, they do acknowledge the importance of that step towards the use of IT in the hospital. Healthcare professionals worry, as Grisby predicts (2002), that there may well be a trade-off between the quality of the patient experience and the use of clinical time. When a technology is not at least as convenient as the process it is intended to replace, productivity suffers. This litigation results in direct patient encounters, but the traceability of diagnosis, cure, and prognosis supported by IT and associated IT tools places them in an awkward position.

In practice, the number of phone calls from parents to the nursing desk dropped. Parents used to call with a 'feeling' that something might be wrong. Parents could now see their new-born themselves (see next section on anxiety lowering visits). The additional phone calls to the nursing desk because of something seen on the VBVS or repositioning of the camera did not exceed the total number of calls, given the drop in phone calls after the VBVS was in use.

3. A decision to adopt or reject the VBVS

The VBVS is medium to low cost e-health. The number of cameras and concurrent streams determines the cost of the VBVS. The average annual costs are approximately 10,000 – 20,000 Euro a year for a system with ten cameras (5 Euro per day per stream). Parents show a willingness to pay of 5 - 10 Euro on a virtual baby system per day. However, in both cases the hospitals did not charge patients for the use of the system since getting sponsorship for the system was relatively easy.

Whitten and Allen (1996) report that innovation in the area of health care is made easier when supported by public funding and when it is well promoted. The cost predictions were low and largely sponsored in both cases. The context of perinatal care made it possible to gather external funding with the support of childcare associations.

4. Implementation of the VBVS

Patients and healthcare professionals are also concerned with security, privacy, and especially confidentiality of their data. Although some patients are interested in more connectivity with the medical system and in monitoring their health, others show resistance to change, particularly to the broadcasting of video on the Internet.

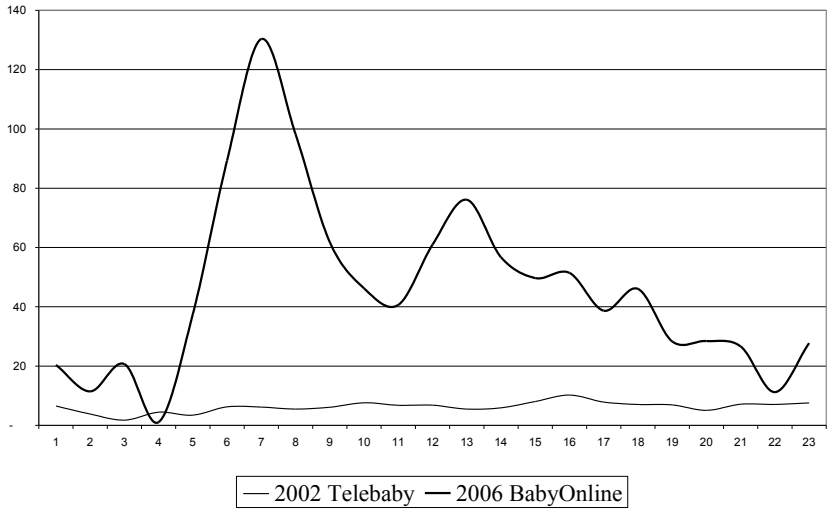
Inside the hospital, the level of internal security systems is characterized as being flexible. Within the walls of the hospital, information must be readily available and flow fluidly. Information flowing across the walls of the hospital is heavily restricted by a 'one gate city wall' to guard privacy. IT departments typically demonstrate resistance to innovations that require crossing the walls of the hospital. They assumed that the security of their systems will be put at risk.

The VBVS were placed behind the hospital firewall. The first generation of the system used the general hospital firewall, whereas the second generation had a separate technical infrastructure and firewall on top of the existing ones at the hospital. No security incidents were reported; however, parents in both cases were informed in advance that the hospital took great care in providing the security system, but that there would always be a chance of the system being compromised, and a stream replaced. All parents signed an informed consent and were well aware of the risk.

5. Confirmation of the VBVS

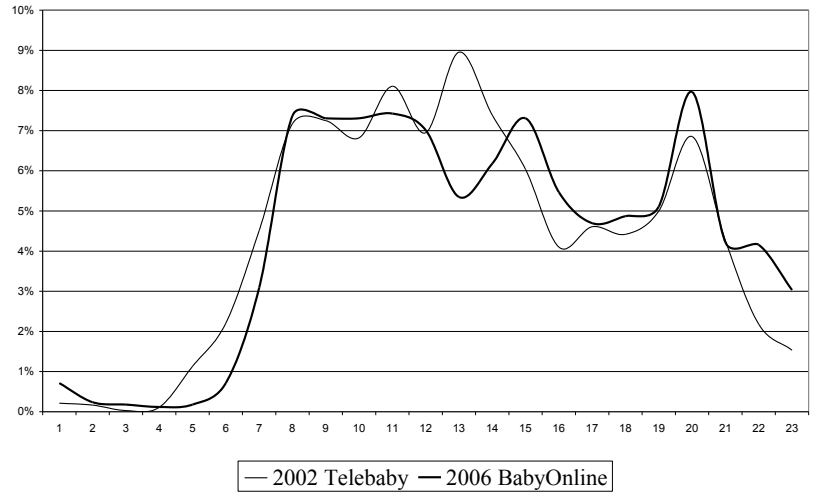
The VBVS was expected to have, and did have, a high promotional value for the hospital. It was a key element in the hospital corporate campaign on innovation, and in both cases it received national media coverage.

Brynjolfson (2000) and Devaraj and Kohli (2003) argue that the driver of IT impact is not the investment in the technology, but the actual usage of the technology. Data gathered a few years after the implementation monitoring of the parents login behaviour showed that the VBVS became a part of their routine (Spanjers and Rutkowski 2007).



Graph 1: Connection frequency distribution

(x = time of day; y = duration view)



Graph 2: Average connection duration

(x= time of day; y = relative distribution of viewing time)

The log files presented in Graph 1 and 2 represent time and duration of the connections of the system usage in frequency for the first generation of the system (n=29,663 records) and for the last generation (n=21.067 records). Log records with duration of three seconds or less, or 12 seconds or less, and less than 372 bytes streaming were not included in the analysis.

These records were mostly generated by the security system in place, do not represent a ‘real’ connection. The monitoring of the log on represents the preferences in time and patterns developed by the parents in visiting their child.

The results are consistent across the years. First, the distribution shows a high connection frequency between 7:00 a.m. and 12:00 a.m., and also around 8:00 p.m. Parents log in during the feeding process, when they cannot physically be present. In the last generation of the system, a drop around 12:00 a.m. is observed in comparison with the first generation. Users with cable connection log on in the morning and stay logged on (see duration). The situation is different from prior to 2003, when there was connectivity through analogue or ISDN phone lines. Also, the average connection duration shows a considerable increase in time from five minutes to 50 after the introduction of cable connection. This is consistent with the findings presented in Chapter 6 in Table 11: Connectivity Dutch Households 1998-2010. The results demonstrate the effect of social presence brought about by the system. Parents may not be sitting behind their computer for 50 minutes, but they do regularly check on their baby. They appear to feel closer when the system is on.

The new generation of system allows parents to virtually visit their baby more often, and they clearly make use of it. Second, the distribution shows a low connection frequency between 4:00 p.m. and 7:00 p.m., and between 9:00 p.m. and 7:00 a.m. At 9.00 p.m., the unit lights dimmed and image quality dropped. Consequently, usage of the system was minimal. The “anxiety lowering” (high frequency, low duration) visits can be seen around 2:00 - 3:00 a.m. and 8:00 p.m. The visits offer parents a certain feeling of control after visiting the unit, most likely they log in to see their baby shortly after coming home.

Over time and per user, the average system use dropped after the first few days, and picked up toward the end of the hospitalisation, exceeding the initial use.

When parents are informed that their new-borns will soon be discharged, they want to make sure that their baby is doing well, and will not be kept longer. The online visit system use on weekends is low, since at that time parents can usually visit their new-born in person.

Another unexpected form of use is reported. Mothers of new-borns use photographs stimulating the lactation process when they produce milk at a time when the new-born is not present. Several mothers discovered the BabyMobile application to be more effective.

The success of the online baby visit system implementation is evident to management of the hospital, physicians, nurses, and IT departments but also to parents. Using the VBVS, the healthcare professionals have increased their responsiveness to the needs of social support for patients. Using the VBVS, the healthcare professionals have learned that well implemented IT innovations are not intrusive to their work, and they respect their rights as well as that of the patients.

Summarizing the three main factors of success in the adoption of the VBVS in this case study:

(i) Healthcare professionals accept the system as an extension of their vision and part of healthcare process; i.e. keeping the relatives and new-born as close together as possible.

(ii) Healthcare professionals and relatives act as if the camera is not there. However, they have the basic right to switch off the connection at any given time, without giving a reason.

(iii) Healthcare professionals are aware that creating the opportunity to be connected is introducing the choice not to be connected.

In Table 7 the two case studies are compared using the e-health frameworks selected in Chapter 3.

Table 7: e-health evaluation frameworks (see Chapter 3) applied to case study

Case	**Telebaby**	**BabyMobile**
Rogers' (1983, 2003) *elements of diffusion*		
Attributes		
- Relative Advantage:	High	High
- Compatibility:	Low	Medium
- Complexity:	Medium	Low
- Trialability:	Medium	Medium
- Observability:	High	High
Social System		
- Change Agent:	Manager Perinatology and Neonatology	Head of Finance and IT
- Opinion Leader:	Manager Perinatology and Neonatology	Head of Finance and IT
Time		
- Critical mass:	Innovator, 1th	Innovator, 6th
- Stages of the innovation-decision process	all stages in 2 year	all stages in 2 year
Innovation-Decision	Contingent innovation decisions	Contingent innovation decisions
Tanriverdi and Iacono's (1998) metaphors of diffusion		
- Communication and influence:	National corporate campaign	Worldwide press attention
- Knowledge barriers and learning:	university setting, open information	open information
- Economic costs and benefits:	cost medium, benefit unknown	cost low, benefit unknown
Contextual factors of Kwon and Zmud (1987) (and Scott Morton (1991))		
- **Organisation** - **Task** - **Technology** - **User community** - **Environment**	*See below*	

Organisation

Research in organisational diffusion indicates the importance of individual leader characteristics and organisational structure (Rogers 1983, Rogers 2003). The managerial open view towards change in health care has been essential to the success of the adoption and diffusion of the first generation of the VBVS.

The management of hospitals in the Netherlands involved in this longitudinal research shared the vision that supporting the medical professional, the IT unit and patient processes of acculturation with IT innovations in the hospital, was a key factor to business success. The management team, initiating the online baby visit project at the hospital, was a corner stone to its successful implementation. Pro-actively and step-by-step, management participated in the implementation of the system and shared its vision summarized in the following statement with the healthcare professionals and IT department: The successful implementation of an online visit system, and more particularly video-streaming of patients, will progressively bring acculturation with new technologies and e-health without being perceived as intrusive to the protagonists. The management style can be best described as consensus-building oriented in the cultural sense of the term (Hofstede 1981, Hofstede, Hofstede and Minkov 2010).

A high degree of alignment amongst finance and IT knowledge has been key to previous success. It has guaranteed low centralization and formalization of the implementation in the organisation. The social ability to focus on business continuity of management and to delegate ownership of a successful system is also key to perpetuating a system that can exist by itself.

Once innovation becomes routine, it is time to work on the next step, preserving richness of the experience and solid reputation. These existing elements should support the organisational acceptance of further research and adoption and diffusion of a new online visit system for a larger, different, group of patients.

Task

Social support is a part of the equation during illness as agued by Donabedian and Fund (1973), presented in Chapter 3. If one were to broaden the topic beyond babies as patients (along with their parents) to include benefits to adult patients; communication is vital. During all of life, from birth to death, isolation is always detrimental to a patient. The task of the digital hospital is to increase communication with patients, to encourage connectivity with relatives. The intangible benefit of social support provided by relatives of patients is well known in hospitals. Visits are encouraged; yet medical reasons often lead to some restrictions (i.e., colds, communicable diseases, limited time for visits and time slots, or children). In such contexts, video streaming facilities allow short visits without travel time to tired adult patients, providing reassurance and social presence.

The positive social psychological effect of relatives' communication on patients' health is rooted in the communicative nature of humans and the importance of verbalisation of emotion. It is well established in the coping literature that the social sharing of emotions with relatives under stressful situations increases psychological adjustment (Herbette and Rime 2004).

Online communities flourishing on health care topics show the human need for exchange and interaction. Patients and relatives need to share their experiences on the disease or treatment they will receive or have received. The popular usage of online healthcare communities is an indicator of the potential of e-health.

Technology

The availability of a television set, a phone connection or even access to the Internet in hospital rooms makes the infrastructure barrier low for introducing a similar online visit system. An interesting question is: can the VBVS be characterized as IT innovation? In the past decades the definition of e-health has evolved towards the use of information and communication technologies in healthcare, as stated by the World Health Organisation (2006). This expression of the expectations we have of IT for healthcare, leaves sufficient room for the VBVS to be interpreted as IT innovation. Typically for the VBVS, is the relative low complexity. It can be classified as a uni-directional on-line streaming video exchange system where the subject (new-born) is being viewed by relatives or healthcare professionals. The subject does not directly benefit from the system, which differs from typical e-health where the subject is also the user.

Online technologies, and more particularly audio-video channels, offer the advantage of facilitating interpersonal interaction. Feedback and social cues supported by video coupled with audio provide rich dimensions to the technology that can be as rich as face-to-face meetings, and this is more particularly true when participants know each other on a personal base.

Facilitating relatives to interact with, and implicitly monitor, their loved ones from a mobile phone is a logical next step. The screens and video capabilities of 3G phones will allow families and patients to check on each other anytime and anywhere.

User community

Electronic communication has been proven to be of medical benefit in conveying social support for patients in stress (Mandl, Kohane and Brandt 1998). Cohen (1988) has demonstrated the importance of social support of relatives in immune and cardiovascular functioning. For example, structural (e.g., marital status, living arrangement) and functional (e.g., family cohesion) social supports have been demonstrated to be an important factor in improving the health of patients at different stages of the diagnosis, prognosis or associated surgery within and beyond the walls of the hospital e.g., increasing adherence to treatment (Goodenow, Reisine and Grady 1990, Helgeson and Cohen 1996, Kulik and Mahler 1989, Uchino, Cacioppo and Kiecolt-Glaser 1996, Uchino and Garvey 1997).

The positive contribution to a patient's health determines the success of IT adoption and diffusion in health care. Online visits should have benefits to patients. It is important that patients are in a reasonably good physical and mental state so that the social support brought by the online system does not interfere with their health. Patients who have just had surgery, have limited mobility, or have been admitted for diagnostic reasons (e.g., symptomatology) would be a user group with maximum benefits. The ethical considerations of proposing the system have to be considered carefully.

Environment

The environmental factors are multiple and entrenched in each of the presented characteristics. Thus far, this case study has emphasised the importance of the need for connectivity and IT in hospitals. The fast expansion of IT, as well as in patient demands, has triggered the need to offer flexibility in connectivity and monitoring.

We have evolved in society to a situation where the pace has increased. Mobility and monitoring have become key concepts. A system that provides the possibility of monitoring a patient anytime and anywhere is key to parents who, for example, stay in a hotel close to the hospital during the first weeks after delivery. It is also key to a wife (and her children) whose husband is hospitalised far away from home, as well as to many other common situations in hospitals.

4.3. Discussion and conclusion

The VBVS is an example of traditional boundaries of hospitals disappearing through the innovative use of IT.

As shown in the case studies, initiators of the VBVS at the initial time of adoption did not know if the application they envisioned would satisfy the expectations. Despite its potential to improve access to healthcare, technical, economic, organisational, and behavioural knowledge barriers can inhibit diffusion of the VBVS. Lack of learning or knowledge in one or more of these areas inhibit the appreciation of the value of the application, and could constitute knowledge barriers to adoption and diffusion.

The burden of lowering these barriers is placed on adopter organisations, since few mediating institutions are available in the market. As university medical centres with many enthusiastic and skilled champions, the study sites are typical of Early Adopters. Thus, they have created technical, economic, organisational, and behavioural knowledge bases to demonstrate that the application actually meets the expectations of potential adopters.

This was the case, as the initiating organisation, an university hospital, distributed its knowledge of the innovation and set out to help other organisations trying to the adoption and diffusion of the VBVS.

CHAPTER 5

Market Analysis

This chapter presents a nationwide market analysis in the Netherlands on the adoption and diffusion of the VBVS over a period of almost 10 years, and generates propositions for further in-depth investigation of adoption and diffusion of IT innovation and IT alignment in hospitals.

The VBVS shows a sustainable social benefit; in 2000, the first example of the VBVS was introduced in the Netherlands. In 2009, almost 50% of all hospitals in the Netherlands provided parents and relatives Internet access to virtually visit their newly born. Since 2007, VBVS has also been provided via mobile phone.

Hospitals that do not have a VBVS are stimulated by the Dutch Foundation of Parents of Incubator Children (2012) that added the availability of the VBVS to the list of hospital perinatal centre care quality criteria (Neo-keurmerk).

A complete and longitudinal market analysis of the VBVS in the Netherlands can provide insight into the phases of adoption and innovation related to the organisational and technological context. Lessons for the adoption and diffusion for future IT innovations in healthcare can be drawn based on this market analysis.

The market analysis uses the classification types from the technology adoption lifecycle model presented in Chapter 2 in order to categorize and analyse the adoption and diffusion of the VBVS: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards.

5.1. Market analysis VBVS in hospitals in the Netherlands

Population

The Netherlands has 99 hospitals: eight university and 85 general hospitals. There are differences between general hospitals, top-clinical hospitals, and university hospitals.

(i) **General hospitals** focus on healthcare service delivery, whereas top-clinical hospitals provide complex healthcare. Research and education are important, but secondary. Physicians are considered to be entrepreneurs; only a minority is on the hospitals payroll. These differences have implications on the selection of the participants for this research, since they naturally influence the categorization of the resources available for IT innovations.

(ii) A sub-set of the, larger, general hospitals is referred to as **top-clinical** hospitals.

(iii) **University hospitals** have a distinctive role in research and education, as well as in innovative healthcare such as transplantations. Further, the majority of the physicians is on the hospitals' payroll. University hospitals still have a partially different reimbursement system, as they historically are co-funded by the Ministry of Education.

In 2008 a nationwide market analysis was held for 93 hospitals. Participating hospitals were those where mainly nurses, team leaders or department heads of neonatal care wards had knowledge of the VBVS.

Six hospitals are excluded being categorical hospitals and private clinics, which service a specific patient population, such as, orthopaedic or rehabilitation hospitals. These hospitals do not provide Neonatal and Obstetric care in a hospital setting, and have no VBVS.

Data collection

The data was collected by phone and e-mail, from October to December 2008, by an independent researcher, based on a list of contacts provided by the Dutch Foundation of Parents of Incubator Children (Vereniging Ouders Couveusekinderen), completed with desk research. The data was updated for hospitals implementing the VBVS in 2009. None of the hospitals that adopted the VBVS terminated the use of the VBVS at a later stage. There were temporary interruptions of services, mostly related to migration to a new or upgraded the VBVS.

To validate and communicate the results of the market analysis, a mini-symposium was organised on June 10, 2009 for a total of 56 participating stakeholders: 30 neonatal and obstetric care nurses, 13 hospital management, 8 researchers, 3 hospital IT specialists, 2 IT vendors. Presentations from stakeholder perspectives were given by neonatal and obstetric care nurses, hospital management, researchers, and hospital IT specialists, and IT vendors which confirmed the research results and initiated discussion on the use and future of the VBVS.

5.2. Results of the adoption and diffusion of the VBVS in hospitals in the Netherlands

The main results of the survey, presented in Table 8, differentiate the hospitals in the adoption phase using a timeline, and categorise hospitals by type. Further details are available in Appendix D and E.

Table 8: Hospital type and adoption classification

	Hospital type			
Adoption phase	General	Top-clinical	University	Total
Innovator	1	1	1	3
Early Adopter	13	5	0	18
Early Majority	19	7	3	29
Late Majority/Laggards	25	14	4	43
Total	58	27	8	93

Significant differences in market share potential

In the Netherlands annually (2010) 124,000 new-borns are admitted to a hospital. The average length of stay is 3.8 days, generating 468,000 nursing days. The VBVS is typically used with unhealthy new-borns as presented in Table 9 and 10. In the Netherlands annually (2010) 74,000 unhealthy new-borns are admitted to a hospital. The average length of stay is 5.1 days, generating 375,000 nursing days.

New-borns admitted in university hospitals have a higher average length of stay (9.4 days) of unhealthy new-borns than general or top-clinical hospitals (4.6 days). In terms of marketshare general and top-clinical hospitals generate more than 80% of the nursing days with the admission (more than 90%) of unhealthy new-borns. There are significant differences in market share potential. Per hospital the VBVS population is the largest in top-clinical hospitals with the potential of 1,254 new-borns per VBVS, followed by university hospitals with 1,175 new-borns per VBVS.

Table 9: Hospital admission of new-borns per type of hospital and healthy/unhealthy in the Netherlands 2000-2010

Type of hospital	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
General Hospital											
Healthy newborn											
Average length of stay	2.5	2.5	2.4	2.3	2.2	2.2	2.1	2.1	2.0	2.0	1.9
Admission	37,729	36,487	35,513	32,854	32,528	31,271	32,197	27,845	26,936	26,370	26,404
Unhealthy newborn											
Average length of stay	6.1	5.9	5.7	5.5	5.4	5.2	5.1	5.0	4.8	4.8	4.6
Admission	41,844	42,463	41,671	40,331	39,695	38,812	37,830	30,621	32,067	32,101	33,257
Average length of stay	4.4	4.3	4.2	4.1	4.0	3.9	3.7	3.6	3.5	3.5	3.4
Admission	79,573	78,950	77,184	73,185	72,223	70,083	70,027	58,466	59,003	58,471	59,661
Top-clinical Hospital											
Healthy newborn											
Average length of stay	2.4	2.4	2.3	2.4	2.3	2.2	2.1	1.9	1.8	1.9	1.8
Admission	6,454	8,264	10,255	12,865	12,540	12,069	13,165	17,948	18,886	21,361	20,456
Unhealthy newborn											
Average length of stay	5.5	5.6	5.8	6.0	5.8	5.6	5.6	5.3	5.1	4.8	4.6
Admission	14,545	14,845	16,092	17,627	17,706	17,688	18,609	25,317	28,594	30,634	33,883
Average length of stay	4.5	4.5	4.4	4.5	4.3	4.2	4.1	3.9	3.8	3.6	3.5
Admission	20,999	23,109	26,347	30,492	30,246	29,757	31,774	43,265	47,480	51,995	54,339
University Hospital											
Healthy newborn											
Average length of stay	3.4	3.6	3.4	3.3	3.3	3.1	3.6	3.8	5.1	3.2	2.8
Admission	3,594	3,131	2,802	2,658	2,611	2,280	2,516	2,408	3,070	2,613	3,223
Unhealthy newborn											
Average length of stay	10.7	10.8	10.8	10.9	11.0	10.5	10.2	10.3	9.7	9.9	9.4
Admission	5,545	5,560	5,387	5,487	5,556	6,096	6,072	5,125	5,407	6,461	7,088
Average length of stay	7.8	8.2	8.3	8.4	8.5	8.5	8.3	8.2	8.0	8.0	7.3
Admission	9,139	8,691	8,189	8,145	8,167	8,376	8,588	7,533	8,477	9,074	10,311
Total											
Average length of stay	4.7	4.7	4.5	4.5	4.4	4.3	4.2	4.0	4.0	3.9	3.8
Admission	109,711	110,750	111,720	111,822	110,636	108,216	110,389	109,264	114,960	119,540	124,311
Nursing days	515,901	514,742	508,068	505,691	488,369	469,499	460,654	440,982	454,751	464,423	468,304

Table 10: Detail hospital admission of unhealthy new-borns per type of hospital the Netherlands 2010

Type of hospital	2010	%	Per hospital
General Hospital (58)			
Unhealthy newborn			
Average length of stay	4.6		
Admission	33,257	44.8%	573
Nursing days	152,982	40.7%	2,638
Top-clinical Hospital (27)			
Unhealthy newborn			
Average length of stay	4.6		
Admission	33,883	45.6%	1,254
Nursing Days	155,862	41.5%	5,772
University Hospital (8)			
Unhealthy newborn			
Average length of stay	9.4		
Admission	7,088	9.5%	1,175
Nursing days	66,627	17.7%	8,328
Total Unhealthy newborn (93)			
Total Average length of stay	5.1		
Total Admission	74,228	100%	798
Total nursing days	375,471	100%	4,037

A group of experts composed of healthcare professionals should be created to set up the rules of thumb and boundaries to online visits. Such rules already apply to traditional visits, and are part of cultural systems and norms.

Based on the case study, the VBVS should primarily be proposed to patients hospitalised with an average length of stay above the typical health care path of five days. Parents of new-born hospitalised less than five days might be in the flow of care and information, leaving ample time and space to benefit from the online visit system.

Moreover, the time required setting up the system and the learning curve of operating such a system are further complications. Also, it is more likely that from a period longer than five days the parents will require more social support from their family. In the long term, family and relatives may have some difficulties to keep up with the regular and intensive rhythm of visits.

With a minimal willingness to pay at least 5 Euro per nursing day for the VBVS service (see also Chapter 4) the market for the VBVS would represent an economic value of 1.9 million Euro; 20.000 Euro per hospital per year; less than 0.7% of the average hospital annual budget for IT and almost 0.002% of the average hospital annual budget.

More than 50% market share after 10 years

The market analysis indicates that after 10 years (in 2009), more than half of the hospitals (54%) had implemented the VBVS. The other half (46%) had not implemented the VBVS; more than half (62%) of these hospitals indicate having the intention to implement the VBVS, and more than five expected they would implement the system that year. Further details are available in Appendix D and E.

No significant geographical spread

As shown in Figure 13 the geographical spread of the VBVS adoption has no significant concentration, other than being related to population density or UMTS 3G (coverage 2007). Further, there is no significant difference in distribution in type of hospital (university, top-clinical, and general hospitals).

There is also no significant difference in distribution in type of hospital care (low care, medium care, high care, post intensive care and intensive care); the VBVS is used in all types of care.

Figure 13: Details market analysis: Dutch Population density, geographical adoption of the VBVS hospitals in the Netherlands, UMTS 3G coverage 2007

Phases of technology co-exist

The market analysis shows that the connectivity of Dutch households the connectivity of Dutch households increased from 1998 to 2010 (14% to 91%) as shown in Table 11 (and Figure 14). From 2002 the availability of broadband Internet increased from 24% to 84%; supporting the enhancing video quality of the VBVS. Tulu (2005) defines this era of e-health as the Internet era.

Table 11: Connectivity Dutch Households 1998-2010

Year	Households with PC	Households with Internet	High bandwidth Internet
1998	0.51	0.14	n/a
1999	0.56	0.23	n/a
2000	0.60	0.38	n/a
2001	0.65	0.48	n/a
2002	0.69	0.55	0.24
2003	0.71	0.59	0.33
2004	0.74	0.64	0.49
2005	0.83	0.78	0.54
2006	0.84	0.80	0.66
2007	0.86	0.83	0.74
2008	0.88	0.86	0.74
2009	0.91	0.90	0.77
2010	0.92	0.91	0.84

Source: National Bureau of Statistics, Netherlands, 2010

Based on the 2009 analysis, a significant number of hospitals (20) have CCTV facilities enhanced with Internet facilities. Hospitals on average have 12 cameras per hospital, with a minimum of one camera and a maximum of 40 cameras. (In contrast, in 2007, only one hospital implemented mobile technology for VBVS.)

Nearly half of the hospitals (20; 48%) that have a VBVS foresee that they will not implement mobile technology for the VBVS mobile technology in the coming years.

IT vendors identify with system

Several IT companies have provided IT solutions over the years; Getronics, Cameramanager, Cybervisie, Infoland, and Hulskamp. The discontinued system, Infoland, is still in use. Also some hospitals have their own development, indicating relatively high involvement of IT departments.

Hospitals identify with system

Hospitals give the system their own identity. The market analysis reveals creative naming: "Baby (in) beeld, Baby in Zigt, Baby mobiel BabyBios BabyCam, Babynet, Babythuiszien, Babyview, Babywatch, Couveusecam, Couveusecamera, CU-live, De babykijker, Familienet, Skybaby, Telebaby, Webcam" indicating high indentification with the system.

5.3. Discussion and conclusion

Swanson (1997) argues that early adoption and diffusion of a technological innovation is based on local, rational organisational choice (satisfier), while later adoption is institutionalized and taken for granted (dissatisfier). Similarly, Swanson and Ramiller (2004) explore differences in innovative behaviour.

As Figure 14 indicates, in 10 years (2009), VBVS became a standard facility in more than 50% of all hospitals in the Netherlands.

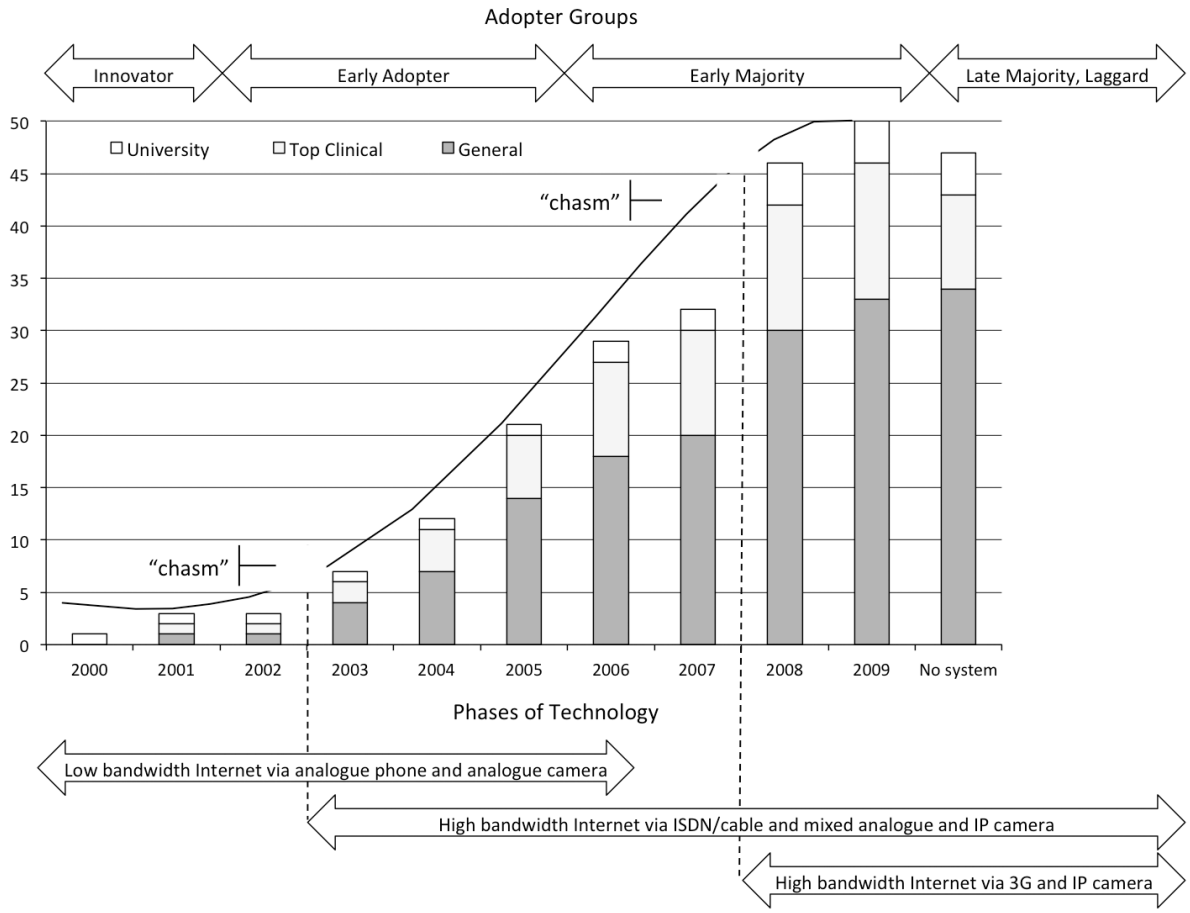


Figure 14: Technology adoption curve of the VBVS:

Adopter Groups and Phases of Technology

Between 2000 and 2002 the system was regarded as being exclusive, and the use was hindered by low consumer bandwidth, allowing low to medium quality video streaming. Between the 2002 and 2003 spurred by the increasing availability of medium to high consumer bandwidth (ISDN and Cable, see Table 10).

A ‘chasm’ (Moore 1991) (Institute of Medicine Committee on Quality of Health Care in America 2001) was clearly crossed between the Innovators (3; 3%) of the product and the Early Adopters (increase with 19%). From 2007 the evolving technologies and Internet, as well as 3G availability for of Dutch households, allowing medium to high quality video streaming, further influenced this increase. A similar chasm can be observed between 2007 and 2008.

Surprisingly, within the relatively small market of the VBVS, several IT vendors developed the VBVS at different stages of the adoption. This was probably caused by the high profile the VBVS could offer an IT vendor, in combination with a relatively low complex and low cost of system development. Additionally, hospital IT departments might have picked up the VBVS for the same reason.

There is one example where the VBVS mobile technology is implemented in another industry: The University Veterinary Hospital Utrecht. The application Telepet was implemented in 2011 after the example of VBVS Telebaby in the University Medical Centre Utrecht. Telepet got national media coverage (see Appendix C).

There are no examples of such a widespread the VBVS adoption in other countries. This might be caused by the fact that the system originated in the Netherlands, the high degree of broadband Internet in the Netherlands, legislative, and cultural differences.

In the author’s experience, parents and healthcare professionals have now accepted the VBVS as part of everyday care. Hundreds of new-borns and their family benefit from it on a daily basis.

The sustainability of the innovation is high. No hospital has terminated the VBVS, although temporary discontinuity of service has occurred in some hospitals migrating towards more advanced VBVS. Hospitals use the system to display their innovativeness and customer intimacy, an example of which is the identity they give their systems. Hospitals that do not have a VBVS are stimulated by the Dutch Foundation of Parents of Incubator Children (Vereniging Ouders Couveusekinderen) that added the availability of the VBVS to the list of hospital perinatal centre care quality criteria (Neo-keurmerk). Nowadays the presence of the VBVS has a positive connotation with future parents selecting a hospital.

This leaves the question how the IT innovation decision-making processes in hospitals function. This question is explored in the following chapter.

CHAPTER 6

Investigating Adoption And Diffusion Of IT Innovation In Healthcare

"The IT governance of this organisation is not well-organised. (...) There are huge IT investments involved (…) the annual financial statements, prepared by the accountant, show that the IT governance is not well- organised. The decisions (…) are not executed in an evenly balanced way."

Head of IT, university hospital (Subject 11)

This chapter presents an in-depth investigation of adoption and diffusion of IT innovation. A focus group of IT management in hospitals is interviewed with the emphasis on elements of the IT innovation decision making process, the influence of the financial resources, IT alignment, and the perceived personal innovativeness on IT adoption and diffusion.

Bonneville (2006) and Bonneville and Paré (2009) explored health IT innovativeness (HIT) antecedents in 106 Canadian hospitals and found that organisational characteristics are related to IT innovativeness irrespective of the public or private nature of hospitals. The authors report the following:

(i) Budget: overall operating budgets are positively related to the level of IT innovativeness in hospitals and the proportion of the overall budget allocated to IT activities is positively related to the level of IT innovativeness in hospitals.

(ii) Hospital type: larger hospitals have higher levels of IT innovativeness than do smaller hospitals, teaching hospitals have higher levels of IT innovativeness than do their counterparts, urban hospitals have higher levels of IT innovativeness than do rural hospitals, and hospitals that belong to a multihospital network have higher levels of IT innovativeness than do independent hospitals.

(iii) Alignment: hospitals with an IT steering committee have higher levels of HIT innovativeness than do their counterparts, the IT tenure of the CIO is positively related to the level of IT innovativeness in hospitals, the number of IT knowledge resources in hospitals is positively related to the level of IT innovativeness in hospitals.

The current exploration is built upon our own previous work to relate the level of IT innovativeness to organisational capacity characteristics (Jaana, et al. 2009, Pare, et al. 2008).

6.1. Investigating adoption and diffusion of IT innovation in healthcare: IT management

The VBVS case study and market analysis reveal a sustainable social benefit that follows a typical adoption and diffusion curve as shown in Figure 14 in Chapter 5. From the case study, it is clear that in the initial phase of adoption, stakeholder alignment played a crucial important role, with IT management 'holding the key.'

Further assessment of the antecedents of IT innovativeness alignment in hospitals and how it is perceived by IT management could provide insights into the phases of adoption and innovation, as well as the underlying IT innovation decision making process. Lessons for the adoption and diffusion for future IT innovations in healthcare can be drawn based on this in-depth investigation.

6.1.1. Propositions

From a longitudinal case study and research on IT innovation in two hospitals in the Netherlands (one top-clinical, one university) and the market analysis, the following propositions emerge.

The success of IT innovation in healthcare, such as the VBVS in hospitals in the Netherlands, depends on IT alignment and perceived personal IT innovativeness, instead of depending on the availability of IT resources and perceived IT innovativeness.

6.1.2. Population

The focus is the larger, urban, teaching hospitals in the Netherlands. Bonneville (2006) and Paré (2009) argue that larger, urban teaching hospitals are more innovative. Therefore 16 hospitals with relative large revenue were selected as a clustered stratified sample, consisting of: 8 university hospitals (100%) and 8 top-clinical hospitals (30%).

With a total annual (2008) revenue of the sample hospitals standing at 7 billion Euro, this sample comprises more than 40% market share of the 17 billion Euro as total revenue for hospitals in the Netherlands. In total, the IT budget of the sample hospitals was 250 million Euro (3.4 %). A sample hospital had on average 400 million Euro revenues, 4,500 employees (FT) and 15 million Euro annual IT budget.

As presented in Table 12 in 43% of the population (7 out of 16), hospitals were included that implemented the VBVS, evenly spread over university (8) and top-clinical hospitals (8).

Table 12: Hospital type and adoption classification; interview population selection

	Hospital type			
Adoption classification	General	Top-clinical	University	Total
Innovator	n/a	0	1	1
Early Adopter	n/a	2	0	2
Early Majority	n/a	1	3	4
Late Majority/Laggard	n/a	5	4	9
Total	n/a	8	8	16

As presented in Table 13 In terms of the total population of hospitals in the Netherlands, 17% (16 of 93) of the hospitals were covered, with 100% coverage of the university hospitals (8), and 30% (8) coverage of top-clinical teaching hospitals.

Table 13: Hospital type and adoption classification; interview population selection percentage total population

	Hospital type		
Adoption classification	General	Top-clinical	University
Innovator	n/a	0%	100%
Early Adopter	n/a	40%	0%
Early Majority	n/a	14%	100%
Late Majority/Laggard	n/a	36%	100%
Total	n/a	30%	100%

6.1.3. Semi-structured interview protocol

For data collection, semi structured interviews (N=16) (Britten 1995) were conducted in a three month period in November and December 2008.

The focus group (N=16) that was interviewed consisted of senior IT management, preferably on the highest level of a dedicated IT position, depending on the way the hospital IT governance was arranged. 50% of them were also leading other departments such as the medical instruments department or medical archives.

All interviewees were male, with 94% above 45 years of age. The majority (81%) held a fixed position, and the rest (19%) an interim position. Interestingly, 26% of the interviewees had a formal education as medical doctor (MD).

The interviews were recorded with an mp3 recorder and transcribed verbatim using speech recognition software. This was done with informed consent of the interviewees. All interviews took place on site, and in a face-to-face situation. The interviews followed a protocol found in Appendix F (Clark and Schober 1992, Doster and Slaymaker 1972). Interviews had a total planned duration of 60 minutes. The actual average recorded duration was 52 minutes. The average number of words per interview was around 6,500, 125 per minute.

In order to increase interviewee satisfaction and ensure recognizance, the interviews were transcribed and distributed within a week after the interview took place. As a result, five interviewees commented on the narrative and requested only minor typographical changes, such as spelling of person names or technical terms. No comments were made regarding the content.

6.1.4. Coding narrative

Narratives are defined as social products that are generated by people in the context of a specific social, historical and cultural location (May 2002). They are interpretive devices through which people represent themselves and their worlds to themselves and others.

Such analysis focuses on the ways in which people make and use stories to interpret the world. Narrative analysis does not treat narratives as stories that transmit a set of facts about the world, and is not primarily interested weather stories are ‘true’ or not. Most interviews are likely to be storied (i.e. in the narrative form).

The transcripts from the recordings were coded using a 4-step method:

i. Defining coding categories and assigning category symbols in line with the research model.
ii. Classifying relevant information and labelling it with the category code and assigning it a unique identification code. First, the relevant information was 'high level' coded by one individual, and a more detailed coding category was then derived. The same individual then recoded using the detailed categories.
iii. Testing and measuring the reliability of coding: the coding of narratives was reviewed independently by a second researcher (double coding), after which results were compared. One of the narratives (Appendix G; 63) gave a conflict in coding (high versus low); a discussion based on the transcripts led to a recoding from the initial 'high' to 'low.'
iv. Locating sources of unreliability: coding results showed no significant differences.

For reference purposes the narratives have been translated in English.

In Appendix F: the variable code list and their sources can be found.

6.1.5. Model

The primary goal of this study is to assess the antecedents of health IT innovativeness alignment in hospitals. This study is built upon the previous work by Bonneville (2006) and Paré (2009) to relate the level of IT innovativeness to organisational capacity characteristics. Our findings indicate the following support for the research propositions.

Table 14: Dependent and independent variables

Dependent Variable DV:
adoption and diffusion of IT innovation in healthcare, VBVS in hospitals in the Netherlands
Independent Variables
IV1. The availability of financial IT resources: high versus low (AFR)
IV2. Perceived IT alignment: high versus low (PITA)
IV3. Perceived innovativeness: high versus low (PI)
IV4. Perceived personal innovativeness influences: high versus low (PPI)

6.2. Analysis

The narratives gathered from the content analysis of the 16 interviews are presented in Appendix G (N=64). The most typical and relevant narrative for each of the 4 variables from 16 subjects are used throughout the analysis.

All 64 narratives have been used to map the propositions, and serve to draw conclusions and are presented in detail in Table 15.

Table 15: Investigating adoption of IT innovation in healthcare

Dependent Variable DV: adoption and diffusion of VBVS	Low	High
		Independent Variable AFR: financial resources IT
Low	2/16 (2, 6)	7/16 (3, 4, 5, 7, 10, 12, 14)
High	2/16 (8, 16)	5/16 (1, 9, 11, 13, 15)
		Independent Variable PITA: perceived IT alignment
Low	4/16 (21, 22, 23, 30)	5/16 (17, 18, 20, 26, 28)
High	4/16 (19, 25, 27, 29)	3/16 (24, 31, 32)
		Independent Variable PI: perceived IT innovativeness
Low	6/16 (34, 35, 37, 38, 39, 46)	3/16 (36, 42, 44)
High	5/16 (40, 43, 45, 47, 48)	2/16 (33, 41)
		Independent Variable PPI: perceived personal IT innovativeness
Low	4/16 (50, 51, 54, 55)	5/16 (52, 53, 58, 60, 62)
High	0/16	7/16 (49, 56, 57, 59, 61, 63, 64)

Independent Variable AFR; the availability of financial IT resources

Financial resources available (AFR) for IT influence the adoption and diffusion of the VBVS (DV).

Based on the literature, we would expect a positive relationship between Availability of Financial resources (AFR) for IT and adoption and diffusion of the VBVS (DV).

Operationalisation variables:

(i) Adoption of and diffusion of the VBVS defined low for Late Majority, Laggard

(ii) Adoption and diffusion of the VBVS defined high for Innovator, Early Adopter, Early Majority

(iii)Financial resources defined low when Hospital IT Budgets as a % of revenue <3%

(iv)Financial resources defined high when Hospital IT Budgets as a % of revenue >=3%

12 of the 16 subjects perceived the financial resources available for IT as high. Therefore the hospital IT budget as % of revenue was used to define and refine financial resources available for IT, with a threshold of 3%.

As shown in Table 15, based on narratives, there is ground to assume a negative relation between AFR and DV when financial resources for IT are low. There is there is no ground to assume a positive or negative relation between AFR and DV. This is consistent with findings of Jaana (2006) that financial constrains are not the main factors affecting the decision to acquire new IT.

In Appendix G the coded values per subject highlights of the subject narrative can be found.

Example narrative Subject 2: AFR low for this subject:

"With the limited group of people I have, those who are there at least, within my department and within the operational information and communication technology, then we are pleased with the projects we were able to finish." (2)

Subject 2 indicates limited resources by referring to the limited group of people in the information and department as an example. Subject 2 indicates the relative low number of projects the IT department can finish, using the word "pleased" in a mitigating sense.

Example narrative Subject 9: AFR high for this subject:

*"This is not a limitation. There are no financial problems. I actually don't have any restrictions as information technologist. No bottleneck in terms of money, so far. I find *** an example of an organisation which can do a lot with IT, because there is a budget. Hence, the strength of the organisation goes hand-in-hand with the money. (9)*

Subject 9 indicates resources are not a limitation, using the word "this" for financial resources. *** in this text is used for anonymity reasons.

Independent Variable PITA; perceived IT alignment

IT alignment Financial (PITA) influences the adoption and diffusion of the VBVS (DV). Based on the literature, we would expect a positive PITA and DV.

University hospitals, mostly considerably larger in size (revenue, number of employees) than top-clinical hospitals, often have a higher degree of decentralization. University hospitals often have a division structure; each division manages a part of their IT resources, either hierarchically or by means of service level agreements. Top-clinical hospitals typically have more centralized IT resources.

There are, however, significant differences concerning the extent of internal stakeholder representation. In some cases, there was no or very low healthcare professional participation in the decision-making process concerning IT innovations. Most hospitals have IT policy boards that represent IT, finance, and the user organisation. The user organisation is mostly represented by a mix of managers and healthcare professionals such as nurses and physicians.

Surprisingly, in none of the cases, a structured external IT stakeholder representation was embedded in the IT policy board. This means that patient organisations have no formal role in decision-making process concerning IT innovations.

Apart from general patient satisfaction, there are no tools that structurally measure the patient's expectations regarding IT innovativeness. There are selection mechanisms in place that in terms of business cases tries to translate to patients the benefits of IT innovations, without contemplating the patients.

The decision-making process by which they depend on these business cases and the translation of the health care professionals of the patients' needs is often based on individual patient contact. Government, healthcare insurance companies, patient organisations and vendors have no formal role in IT policy boards. Most IT managers regard management and health care professionals as their most important stakeholders. Their focus is on internal stakeholders.

Operationalisation variables:

(i) Adoption and diffusion of the VBVS defined low for Late Majority, Laggard

(ii) Adoption and diffusion of the VBVS defined high for Innovator, Early Adopter, Early Majority

(iii)Perceived IT alignment defined low based on interview narrative

(iv)Perceived IT alignment defined high based on interview narrative

As shown in Table 15, based on narratives, there is no ground to assume a positive or negative relation between PITA and DV.

In Appendix G the coded values per subject highlights of the subject narrative can be found.

Example narrative Subject 11: PITA low for this subject:

"The IT governance of this organisation is not well-organised. (...) There are huge IT investments involved… the annual financial statements, prepared by the accountant, show that the IT governance is not well organised. The decisions … are not executed in an evenly balanced way." (27)

Subject 11 indicates that the technology governance is not well organised; referring to external legitimation (the accountant's annual report).

Example narrative Subject 4: PITA high for this subject:

"The directorate IT is one of the major directorates. Besides that, IT contains four groups, decentralised IT groups in division one to four. (...) What we currently do in the context of the IT Directorate, is to conduct consultations every two months with all the IT contacts in the relevant departments, in order to check which progress they make. Which new ideas they have." (20)

Subject 4 indicates a high level of decentralisation of IT innovation decision making processes and high involvement of stakeholders in IT innovation processes.

Independent Variable PI; perceived IT innovativeness

IT innovativeness (PI) influences the adoption and diffusion of the VBVS (DV). Based on the literature, we would expect a positive relationship PI and DV.

Operationalisation variables:

(i) Adoption and diffusion of the VBVS defined low for Late Majority, Laggard

(ii) Adoption and diffusion of the VBVS defined high for Innovator, Early Adopter, Early Majority

(iii) Perceived IT innovativeness defined low based on interview narrative

(iv) Perceived IT innovativeness defined high based on interview narrative

As shown in Table 15 based on narratives, there is no ground to assume a positive or negative relation between PI and DV.

In Appendix G the coded values per subject highlights of the subject narrative can be found.

Example narrative Subject 13 PI low for this subject:

"It's just what you call it. If you cut and paste external technology, then you're innovating compared to others. That's a relative innovation, but do you really innovate? (...) We run faster than the company. But in your IT department, there always is a tension between managing and innovating. Management is necessary, and that's the way it works. If it fails, you will be judged on your management. If the whole server park crashes, you have a problem." (45)

Subject 13 indicates that innovation is relative. The IT department is relatively leading in innovation compared with the rest of the organisation; suggesting that the balance between managing the operational processes and innovating hinders the overall innovativeness.

Example narrative Subject 4 PI high for this subject:

"Then I think, we score an eight if I compare our situation with the general hospitals that I have seen, and those are usually the larger hospitals. (...) When looking at colleagues, I think that, generally spoken, we are pretty average or slightly above the average, in terms of innovation. (36)

Subject 4 indicates the innovativeness of the organisation as 6-7 on a scale of 10, being hindered by choices made in the past, initially giving the organisation a leading position.

Independent variable PPI; perceived personal IT innovativeness

Perceived personal IT innovativeness (PPI) influences the adoption and diffusion of the VBVS (DV). Based on the literature, we would expect a positive relationship between PPI and DV.

Markus and Benjamin (1996) discovered widely differing views about what it means to be a change agent. IT managers do not always see the need to change; they already view themselves as effective change agents.

Agarwal and Prasad (1998) hypothesized the construct, personal innovativeness in the domain of IT, to exhibit moderating effects on the antecedents as well as the consequences of individual perceptions about a new IT. Personal innovativeness in the domain of IT is defined by Agarwal and Prasad (1998) (p. 3) as "the willingness of an individual to try out any new IT."

Operationalisation variables:

(i) Adoption and diffusion of the VBVS defined low for Late Majority, Laggard

(ii) Adoption and diffusion of the VBVS defined high for Innovator, Early Adopter, Early Majority

(iii) Perceived personal IT innovativeness defined low based on interview narrative

(iv) Perceived personal IT innovativeness defined high based on interview narrative

As shown in Table 15, based on narratives, there is ground to assume a negative relation between PI and DV.

As shown in Table 15, based on narratives, there is ground to assume a positive relation between PI and DV.

In Appendix G the coded values per subject highlights of the subject narrative can be found.

Example narrative Subject 3 PPI low this subject:

"No, I try to put it forward, and I do put it forward. Above all, I put my energy in continuity, availability and short lead time of projects. And certainly not starting projects with unclear outcomes." (51)

Subject 3 indicates a personal focus on continuity, not on innovation. Subject 3 has a negative association towards innovative projects referring to them as "projects with unclear outcomes".

Example narrative Subject 5 PPI high for this subject:

"Nice! Nice to see innovation, it's nice to see new processes emerging, to gain new experiences, to discover things. That is something that really appeals to me. The creativity, which you encounter in innovation. Making new things possible. Which also leads to the improvement of the healthcare, and sometimes, that can be extremely gratifying." (53)

Subject 5 indicates a positive association towards innovations referring to the creativity and experience related to innovations.

6.3. Discussion and conclusion

The results of the in-depth investigation of adoption and diffusion of IT innovation with a focus group of IT management in hospitals demonstrates that financial resources, alignment and perceived IT innovativeness do not play a significant role in IT and adoption and diffusion of IT innovations such as the VBVS. A positive relation is suggested between perceived personal IT innovativeness and adoption and diffusion of IT innovations such as the VBVS.

The findings suggest that financial constrains are not the main factors affecting the decision-making process of investments in innovative IT. However, it remains difficult for IT management to identify the intangible benefits of investments in innovative IT in healthcare and exploit its full potential.

Investments in innovative IT in healthcare may create new outcomes of care or change outputs or outcomes; often difficult to identify and quantify in monetary terms, partly because detecting them depends on our expectations or knowledge of effects on health or other intangible outcomes such as: increased access to health services, cost-effectiveness, enhanced educational opportunities, improved health outcomes, better quality of care, better quality of life, and enhanced social support.

Also, detecting benefits may depend on timing, with some benefits only becoming apparent at a time in the future. IT management has to find a way to recover the investments in innovative IT in healthcare. Since benefits will take time to be realized, in healthcare are often intangible by nature, and not always occur in areas directly related to the use of the innovative IT, it is difficult to attribute them directly to changes in IT.

Clemons (1991) argues that the increasing competitive impact of IT, makes the IT innovation decision-making process challenging for management.

Traditional methods, such as Net Present Value (NPV) are directed toward economic precision. When decision makers cannot precisely estimate benefits accurately, often the value of intangible benefits are set to a zero value. However, it may be possible to estimate them with enough accuracy to rank alternatives. Not the decision's NPV in absolute terms but a NPV that is superior to (less negative than) the alternatives. When an IT innovation can involve a substantial additional investment, it is increasingly difficult to justify the negative NPV. Clemons identifies this mechanism as ‘the trap of the negative net present value’.

Sometimes a sensitivity analysis of alternatives can capture uncertainty. Not continuing the status quo while a competitor will choose to implement an innovative information technology the alternative is to face a deteriorating competitive position resulting in loss of market share and eventually reduced margins. Clemons identifies this mechanism as 'the trap of the vanishing status quo'.

Alignment of IT decision-making process with objectives and strategy while being compliant with government policy and regulations is a significant issue in health care organisations. Identifying the organisation objectives and organisation strategy is a elementary step for IT management in this process. Mission statements have become increasingly important in the complex and dynamic environments health care organisations operate.

Spanjers (Spanjers 2007) make an international comparison of hospital mission statements (n = 261). Based on the co-occurrence of key phrases and words, a typical complete mission statement for a hospital would be composed as follows: "to provide quality healthcare to our patients that is compassionate, cost-effective, patient-oriented and while doing that contribute to research and education of healthcare professionals."

Key elements (as presented in Figure 15 and Table 16) in hospital mission statements are: healthcare, patient, quality, provide, compassionate, cost-effective, patient-oriented, and research & education. The strongest co-occurrence of key elements lies in 'healthcare', 'patient', and 'quality', of 0,76. The co-occurrence of the element 'compassionate' is 0,58 and that of 'cost-effective' 0,4.

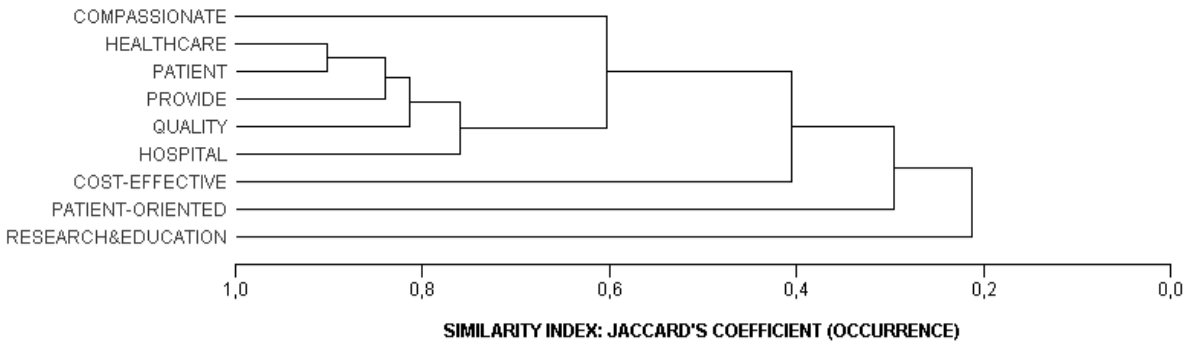


Figure 15: Dendrogram hospital mission statements,

similarity index: Jaccard's coefficient (occurrence, n = 261)

Table 16: Keyword co-occurrence hospital mission statements (n = 261)

Keyword co-occurrence hospital	Co-occurs	Do not	Is absent	Jaccard
Healthcare	205	49	6	0.788
Patient	197	45	14	0.770
Quality	188	37	23	0.758
Provide	186	42	25	0.758
Compassionate	138	27	73	0.580
Cost-Effective	90	12	121	0.404
Patient-Oriented	65	10	146	0.294
Research & Education	52	7	159	0.239

The structure of the keywords in hospital mission statements reflects the nature of decision-making processes in hospitals where intangible factors like quality and compassion a substantial role, economic factors play a more enabling role.

However, this is not found in the way IT innovation decision-making process is structured. In some cases, there was no or very low healthcare professional participation in the decision-making process concerning IT innovations.

Most hospitals have IT policy boards that represent IT, finance, and the internal user organisation. A mix of managers and healthcare professionals such as nurses and physicians mostly represents the internal user organisation.

Healthcare organisations can stimulate alignment by educing and controlling difficult potential political discussions between the CFO and CIO (Grover, Jeong, Kettinger and Lee 1993, Senn and Porrello 2005). IT management in healthcare should therefore promote increased the awareness regarding the business contribution of IT, and to promote a richer evaluation culture including the consideration of intangible corporate benefits and social benefits and the associated risks.

Consistent with the research of Markus and Benjamin remain (1996) there is ground to assume a positive relation between perceived personal IT innovativeness the adoption and diffusion IT innovations. IT managers do not always see the need to change; they already view themselves as effective change agents.

Personal innovativeness in the domain of IT can potentially be utilized to enrich more broadly focused models of IT adoption and diffusion that include constructs other than individual beliefs or perceptions as drivers of the decision-making process of adoption and diffusion IT innovation.

To roll out VBVS effectively, IT management maintained a positive relationship with their stakeholders and engage in extensive information sharing across organisational levels by applying a bottom–up approach rather than solely emphasizing a top–down approach.

Thakur, et al. (2012) argue that executives and practitioners should be open to any suggestions and changes, and they should align their decision-making strategy with the mission of the company while being compliant with government regulations.

The relative negligible economic effect of the VBVS investment far outweighed the intangible effects in the innovation-decision process. The needs driven VBVS was supported by policy and top-management with a high perceived IT innovativeness, had high promotional value, and identification with the innovation are examples of these intangible effects that supported the adoption and diffusion of the VBVS technology.

Surprisingly, in none of the cases, a structured external IT stakeholder representation was embedded in the IT policy board. This means that patient organisations have no formal role in decision-making process concerning IT innovations. Apart from general patient satisfaction, there are no tools that structurally measure the patient's needs regarding IT innovativeness. There are selection mechanisms reported that in terms of business cases tries to translate to patients the intangible benefits of IT innovations; but without contemplating the patient, or patient organisations.

CHAPTER 7

Discussion And Conclusion

"It might not be politically correct to say this,
we are patient centred,
but when it comes to IT innovation,
the patient is not in the centre,
the patient is in the way"

Head of IT and innovation (and MD), university hospital (subject 12)

This chapter integrates and discusses the outcomes and limitations of this research, and presents the conclusions of this research and concludes with suggestions for further research.

7.1. Discussion

Although the definition of innovation as defined by Schumpeter (1934) as the introduction of a new good is straight forward, in practice, especially with intangible goods as software, pinpointing the actual innovation remains difficult.

We thus return to the question whether e-health can be characterized as IT innovation. In the past decades, the definition of e-health has evolved towards "the use of information and communication technologies for health" as stated by the World Health Organisation (2006). This is an expression of the expectations we have of IT in the context of healthcare, leaving sufficient room for e-health to be interpreted as IT innovation.

This research uses Rogers' (1983, 2003) main school of thought on innovation diffusion theory, combined with new theory on the emerging field of e-health. This combination is needed, since the technology adoption and the step-change technology of Rogers' model of innovation can be challenged (Moore 1991). The basic invention-innovation-diffusion model does not always fit the multilevel, non-linear processes stakeholders participate in to create successful and sustainable innovations.

However, Rogers' (1983, 2003) is both comprehensive and specific. It provides a framework for analysis of the diffusion of innovations at a complex systems level, taking into account the differences in users, rate of adoption, types of information and decisions, and communication channels, while simultaneously facilitating identification of highly specific attributes of an innovation that affect diffusion.

The European policy on innovation and IT combined with the European policy on healthcare provide clear outlines in an action plan for European e-health. The current action plan for European e-health (European Community 2004), encourages local governments to develop their own action plans. About half of the world's nations have some form of e-health policy but little commonality in what they aim to achieve (Mars and Scott 2010). Although expectations of the contribution e-health are resonated, The Dutch National e-health policy is not specific enough to use as guideline to meet these expectations.

Furthermore, in the European policy e-health is seen as "today's tool for substantial productivity gains, while providing tomorrow's instrument for restructured, patient-centred health systems and, at the same time, respecting the diversity of Europe's multi-cultural, multi-lingual health care traditions."

It is doubtful that this approach is realistic, given the productivity paradox which argues (Attewell 1994, Brynjolfson 2000) that IT can even have negative or insignificant impacts on firm productivity. The productivity paradox, while having positive and significant impacts on others, substantiates the value of IT. In this research, although longitudinal, it remains difficult to capture the cumulative outcome over time.

On a process level, healthcare has unparalleled complexity. The complex field of stakeholders underline that the adoption of technology in health care organisation is influenced by instrumental consideration but also by non-instrumental factors such as culture or politics, as suggested by Prasad and Prasad (1994). This current research focuses on the IT alignment and the role stakeholders play in the innovation decision-making process.

Especially in a complex field as healthcare characterized by improvisations of unexpected outcomes, traditional alignment literature can be theoretical. Traditional IT alignment models such as MIT (Scott Morton 1991) and SAM (Henderson and Thomas 1992, Henderson and Venkatraman 1993) provide useful elements to analyse IT-alignment in healthcare.

Chan and Reich (2007) present interesting counter-arguments: alignment research is mechanistic and fails to capture real life, alignment is not possible if the business strategy is unknown or in process, alignment is not desirable as an end in itself since the business must always change, and IT should often challenge the business, not follow it.

Specific e-health frameworks enhance the traditional IT alignment models to allow a more healthcare specific classification and analysis. Given the nature of e-health, its evaluation requires careful specification of both input and output variables. In health sciences, defining output especially remains a delicate area; economists find refuge in QALYs (Quality-Adjusted Life Year), assessing the value for money of a medical intervention.

For an IT innovation (such as e-health), more specific the VBVS and a broader perspective (such as the health outcome model of Donabedian and Fund (1973))are useful. It encompasses intangible socio-economic benefits, including, better quality of care, better quality of life, and enhanced social support (Beard and Elo 2007, Wootton and Hebert 2001). Stakeholders should use these intangible benefits to justify moving along the IT opportunities matrix to a position where investments in innovative IT at least pay for themselves with improved quality at constant cost.

However, measuring intangible benefits is difficult and generalizability remains low. Therefore, innovation decision processes often face the question of who will provide input when the output is uncertain. This explains why there are positive innovation decision processes when there is adequate funding. The reason that many e-health projects fail to survive beyond the funded research phase is that they are not needs-driven (Brebner, et al. 2005). According to Goldzweig, et al. (2009) stimulating the adoption of IT innovations in healthcare will therefor require greater public-private partnerships, new policies to address the misalignment of financial incentives, and a more robust evidence base regarding IT implementation. These findings are consistent with this research.

The VBVS is an example of traditional boundaries of the hospital disappearing by innovative use of IT. With the relatively low cost and low complexity, high profile e-health applications can contribute to the well being of patients and their relatives. VBVS is needs driven, as one of the first BabyMobile users commented: “This is most valuable content I can imagine on my mobile device.” Relatives want to have access to this content, and although most of the VBVS are subsidized by foundations or hospital IT budgets, relatives are willing to pay more for the service than the actual cost.

As shown in the case studies, initiators of the VBVS at the time of initial adoption did not know if the application they envisioned would satisfy the expectations. Despite its potential to improve access to healthcare, it is the technical, economic, organisational, and behavioural knowledge barriers that can inhibit adoption and diffusion of the VBVS. Lack of learning or knowledge in one or more of these areas inhibits the appreciation of the value of the application, and could constitute knowledge barriers to adoption and diffusion.

This VBVS market analysis shows that adopters use e-health consistently, frequently, and assiduously when they are convinced that applications are technically and economically feasible, medically valid, and supported by policy.

7.2. Limitations for this research

All research suffers from limitations. In this research the following main limitations are acknowledged: IT in healthcare is a complex and large field of research, longitudinal case study research and market analysis generates specific methodological limitations.

IT in healthcare is a complex and large field of research

Healthcare is a complex field and large of research. Innovation and adoption of IT innovations in healthcare affects organisations at different levels. Therefore, the current research uses multi-level theory and mixed levels of analysis, case study, and triangulation.

The use of generally accepted, not healthcare specific, theory from different fields of science on adoption and diffusion and alignment, implicates selecting and combining theories in a way that they do not have overlap, hindering the research.

The theory from different fields used in this research, strengthens the multi-level approach towards the definition of e-health and e-health frameworks.

Due to the nature of the research design employed, this research does identify the impact of the VBVS on organisational performance. Devaraj and Kohli (2003) suggest that actual usage may be a key variable in explaining the impact of technology on performance, implying that omission of this variable may be a missing link in IT productivity analyses. In the case study, actual use is measured over a limited time to compare and analyse the use during the day of two VBVS, and not to analyse the organisational performance.

Although this research found a number of areas of intangible socio-economic benefits, there is the continuing problem of limited generalizability. This research is limited to the national context of the healthcare system in the Netherlands. Also the specific aspects of VBVS limit the generalizability.

Methodological aspects of longitudinal case study research and market analysis

Pettigrew (1990), addresses the practical problems that include: dealing with time in longitudinal research; issues of site selection; choices about data collection and degrees of involvement; the importance of clarifying research outputs, audience, and presentation; and finally handling problems of complexity and simplicity associated with longitudinal comparative case study research on change.

This current research uses multi level theory, mixed levels of analysis, and triangulation. Further, the research is longitudinal, spanning almost 10 years and 150 participants from healthcare, from IT managers to patients.

A number of participants were not present at the time when the innovation decision process for the VBVS took place; this might affect the operationalization relation between the perceived personal innovativeness and the diffusion of the VBVS.

Although these different views at different times might affect the accuracy of the conclusions, this is outweighed by the increase of validity (Bashshur (1995), Bashshur and Shannon (2005), and Denzin (1994).

Measuring perceptions on the IT innovation decision-making process

This research presents an in-depth investigation of adoption and diffusion of IT innovation. A focus group of IT management in hospitals is interviewed with the emphasis on elements of the IT innovation decision making process, the influence of the financial resources, IT alignment, and the perceived personal innovativeness on IT adoption and diffusion.

Denis, Hébert, Langley, Lozeau, and Trottier (2002) suggest the mutual influence between innovations and adopting systems, and the sometimes desirable and sometimes undesirable effects on adoption patterns. The diffusion and adoption of innovations is a social and political process, in which the benefits and risks of technologies are distributed unevenly, are locally defined, and have differentiated influences on individual decision makers and their perceptions (Moore and Benbasat 1991).

Fleuren, Wiefferink and Paulussen (2004) suggest that also measuring the degree of implementation of innovations could be improved by asking both users and non-users why they accepted or rejected the innovation.

7.3. Conclusion

Healthcare spending is increasing, and has become a factor of economic and political importance in Europe. Healthcare organisations have to modify their business to remain competitive. It is clear that IT innovations can aid healthcare organisations in improving their processes and providing better healthcare with fewer or equal resources. IT innovations have the potential to revolutionise healthcare and health systems, and to contribute to their future sustainability.

This emerging field in the intersection of medical informatics, public health, and business, referring to healthcare services and information delivered or enhanced through the Internet and related technologies, became known under the term 'e-health' in the late 90's, as a way of characterizing these technologies. The World Health Organisation (2006) proposed a compact definition of e-health: "the use of information and communication technologies for health".

Even with its potential to lower costs and transform healthcare, the technical, economic, organisational, and knowledge barriers seem to hinder the adoption and diffusion of IT. Rogers states (p. 388): (2001) "One of the challenges for future diffusion research is to study innovations that would contribute to the public good but that diffuse slowly."

The adoption and diffusion of IT innovations in healthcare is slow. The research question thus is: Can we stimulate the adoption and diffusion of IT innovations in healthcare?

Healthcare has unparalleled complexity. This complexity is mirrored in the healthcare IT innovation decision process where stakeholders may have embedded conflicts of interest.

Adoption and diffusion of innovations follow a typical innovation decision-making process and adopters are categorized by a model, led by normal distribution. In real life we find a chasm in the early stages of adoption. Crossing this chasm has been an important topic on the policy agenda of the European Union, expecting that IT innovations can help to provide better patient-centred care, as well as lower cost of healthcare delivery. An action plan on a European level provides outlines for national policies. In their latest policy statement the Dutch Department of Healthcare states that IT innovations can enable changes in the healthcare delivery process needed to guarantee access in the future.

Generic alignment models such as the Massachusetts Institute of Technology (MIT) model or the Strategic Alignment Model (SAM) can aid healthcare to align the IT innovation decision process. However, healthcare in its nature deals with unexpected outcome. Therefore, healthcare specific frameworks are used to enhance the traditional IT alignment models to allow a more healthcare specific classification and analysis.

The innovation and adoption of IT innovations in healthcare affects organisations at different levels. In researching these phenomena, multi-level theory and mixed levels of analysis is suggested.

This research generates insight into the adoption and diffusion of an IT innovation in healthcare presented in a longitudinal case study analysis of a specific e-health application Virtual Baby Visit System (VBVS) in two hospitals in the Netherlands. The VBVS is an Internet based facility providing a live video stream that links parents to their hospitalised new-born.

The case study is analysed along the stages of the innovation-decision process: the first knowledge of an innovation, towards forming an attitude toward the innovation, the decision to adopt or reject, the implementation of the innovation, and the confirmation of the decision.

The VBVS is an example of traditional boundaries of hospitals disappearing through the use of innovative IT. A nationwide market analysis in the Netherlands on the adoption and diffusion of the VBVS over a period of almost 10 years generates propositions for further in-depth investigation of adoption and diffusion of IT innovation and IT alignment in hospitals. After 10 years, the VBVS shows a sustainable intangible socio-economic benefit; in 2000, the first example of the VBVS appeared in the Netherlands. In 2009, almost 50% of all hospitals in the Netherlands provided parents and relatives Internet access to virtually visit their newly born. Between 2000 and 2002 the system was regarded as being exclusive, and the use was hindered by low consumer bandwidth, allowing low to medium quality video streaming. Between 2002 and 2004 clearly a 'chasm' between the Early Adopters of the VBVS (technology enthusiasts and visionaries) and the Early Majority (pragmatists) was crossed, spurred by the availability of medium to high bandwidth (ISDN and Cable).

The increase was further influenced by the evolving technologies and Internet, as well as 3G coverage of Dutch households, allowing medium to high quality video streaming. Within the relatively small market of the VBVS, several IT vendors developed the VBVS systems at different stages of the adoption. This was probably caused by the high profile the VBVS could offer an IT vendor, in combination with a relatively low complex and low cost of system development.

In the author's experience parents and healthcare professionals have now accepted the VBVS as part of everyday care. Hundreds of new-borns and their family benefit from it on a daily basis. The sustainability of the innovation is high. No hospital has terminated the VBVS, although temporary discontinuity of service has occurred in some hospitals migrating towards more advanced VBVS.

Hospitals that do not have a VBVS are stimulated by the Dutch Foundation of Parents of Incubator Children (Vereniging Ouders Couveusekinderen) that added the availability of the VBVS to the list of hospital perinatal centre care quality criteria (Neo-keurmerk).

There is one example where the VBVS mobile technology is implemented outside the neonatal care: Telepet in the University Veterinary Hospital Utrecht.

Surprisingly, there are no examples of such a widespread VBVS adoption in other countries. This might be caused by the fact that the system originated in the Netherlands, the high degree of broadband Internet in the Netherlands, legislative, and cultural differences. These are interesting areas for future research.

An in-depth investigation of adoption and diffusion of IT innovation with a focus group of IT management in hospitals suggest that financial resources, alignment and perceived IT innovativeness do not play a significant role in IT and adoption and diffusion of IT innovations such as the VBVS. A positive relation is suggested between perceived personal IT innovativeness and adoption and diffusion of IT innovations such as the VBVS.

This research combines 10 years of research with 20 years of field experience, with contributions of over 150 participants from healthcare, from IT managers to patients. Three factors played an important role in the IT innovation alignment for the VBVS: economy, policy and technology. The results of this research lead to the following conclusions (see Figure 16):

Economy - The VBVS in the Netherlands represent an potential economic value of 1.9 million Euro; less than 0.7% of the average hospital annual budget for IT and almost 0.002% of the average hospital annual budget. The relative negligible economic effect of this investment far outweighs the intangible effects in the innovation-decision process. Support of the policy, high promotional value, and identification with the innovation are examples of these intangible effects that supported the adoption and diffusion of the VBVS technology.

Policy - New and unfamiliar technologies can generate ethical concerns, and issues such as trust and confidence, that must be addressed. Hospital policy and legislation in the Netherlands was not a barrier in the adoption and diffusion of the VBVS.

A key element in the adoption of the VBVS is the policy commitment of the perinatal centres to provide family centred care, in a healing environment; supporting the development of the new-born beyond the boundaries of the hospital. This policy stimulated the healthcare professionals in the adoption and diffusion of the VBVS technology.

Technology - Over time the technology evolved and supported the sustainability of VBVS. The increasing quality and availability of bandwidth supported higher image quality and accessibility, stimulating the VBVS through the phases of adoption and diffusion.

Patient - IT management played a crucial role in the IT alignment process of the VBVS, their patient centred approach was favourable in the decision-making process, stimulating the nationwide adoption and diffusion of the VBVS.

However, IT management in healthcare organisations still has an internal focus when it comes to IT innovations; at best, healthcare professionals are treated as customers, instead of the patients. When IT management realises that the actual adoption and diffusion of an IT innovation in healthcare is an expression of the intangible benefit it brings the patients...
... IT management can consider stimulating the adoption and diffusion of IT innovations by aligning the decision making process around the patients' needs, and literally 'be patient.'

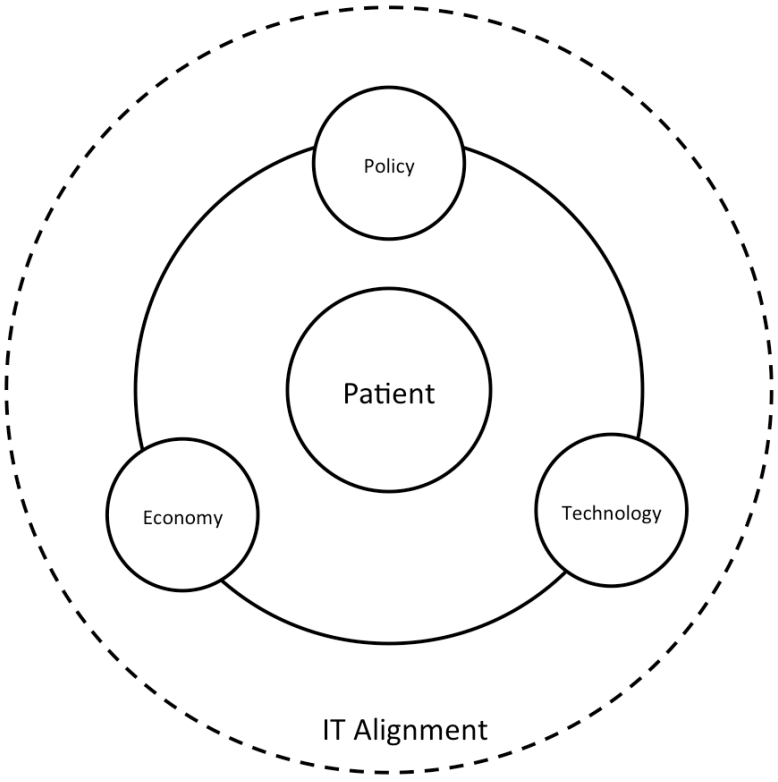


Figure 16: Factors in IT innovation alignment in healthcare

Appendix A

Details case study: overview system evolution and phases of technology

Chronology		1999	2000	2003	2007
Phase of technology		Telebaby CCVTV	Telebaby Closed Camera Ciruit to Internet	BabyOnline I IP camera to Internet	Baby Online to Baby Mobile IP camera to Internet and mobile phone (under development)
Connection Infrastructure	Internal	Camera: analogue camera (Panasonic Super Dynamic Colour Camera WV-CP454) Client: television set	Camera: analogue camera (Panasonic Super Dynamic Colour Camera WV-CP454) Client: Television set	Camera: IP streaming camera (Sony SNC-P1) Server: one streaming server, one firewall server Client: Personal computer with internet connection	Camera: IP streaming camera (Sony SNC-P1) Server: one streaming server, one firewall server Client: Personal computer with internet connection
	External	Not available	Camera: analogue camera (Panasonic Super Dynamic Colour Camera WV-CP454) with on-line realtime digitalizing analogue image signal (4 Osprey 200 per personal computer 800 MHz, 16 Gb 522 Mb) Server: one streaming server, one firewall server Client: Personal computer with internet connection	Camera: IP streaming camera Server: one streaming server, one firewall server Client: Personal computer with internet connection	Camera: IP streaming camera Server: one streaming server internet, one streaming server mobile phone, one firewall server Client: Personal computer with internet connection or mobile 3 G phone with QVQA to VGA
Connection flexibility	Internal	Low: image collection points are fixed by the closed camera circuit inlets (50) and image reception points are limited by the television sets mounted (50)	Low-Medium: image collection points are fixed by the closed camera circuit inlets (50) and image clients are limited by connection to computer network with internet access	Medium-High: image collection points and image clients are limited by connection to computer network with internet access	Medium-High: image collection points and image clients are limited by connection to computer network with internet access
	External	Not available	Low-Medium: image collection points are fixed by the closed camera circuit inlets (50) and image clients are limited by connection to computer network with internet access	Medium-High: image collection points and image clients are limited by connection to computer network with internet access	High: image clients are expanded with mobile devices.
Bandwith	External	Not applicable	Depending on client connection, often analogue modem 56K or ISDN one or two lines.	Depending on client connection, often ISDN, ADSL or Cable	Depending on client connection, often ISDN, ADSL or Cable. Mobile phones GPRS or UMTS, allowing 10 or more frames per second (400 bit maximum, 100 bit average)
Privacy access	Internal	Point to point access allows only admitted mother and visitors to see images on television set mounted above bed.	Point to point access allows only admitted mother and visitors to see images on television set mounted above bed.	Access code sharing possible.	Access code sharing possible.
	External	Not available	Access code sharing possible.	Access code sharing possible.	Access code sharing possible.
Support beside IT		Television set required no further instruction	Personal and written instruction for internet connection	Personal and written instruction for internet connection	(under development)

Appendix B

Questionnaire case study 1: UMC-Utrecht Telebaby

Question 1.
Who uses the Telebaby-system?
Pick one answer

O	Mother
O	Father
O	Both

Question 2.
How often did you use the Telebaby-system?
Pick one answer

O	Daily
O	A few times a week
O	Once every week
O	Almost never

Question 3.
If you did not use the Telebaby system a lot, what was the cause of this? (skip if not applicable)
Pick maximum three answers

		Max.3
1.	The image quality was not what I expected.	□
2.	Often I did not see my baby (black or blue screen).	□
3.	I was not interested.	□
4.	It made me anxious.	□
5.	It is expensive due to the Internet costs.	□
6.	I did not have enough time to log in.	□
7.	My computer wasn't suitable for Telebaby.	□

Question 4.
How often did you not see your baby when you logged in (blue or black screen)?
Pick one answer

O	Almost always
O	Often
O	Not often
O	Almost never

Question 5.
How important was it for you that you always saw your child when logging in? (not getting a black or blue screen)
Pick one answer

☐	Very important	☐	Reasonably important	☐	Neutral	☐	Not really important	☐	Not important at all

Question 6.
Below are two statements. Please pick per statement an answer on the scale that describes the way you feel.

Pick one answer

Statement: By using Telebaby I could simply see my baby.				
☐ Very important	☐ Reasonably important	☐ Neutral	☐ Not really important	☐ Not important at all

Statement: I could share my login-data so friends and relatives could see my baby too.				
☐ Very important	☐ Reasonably important	☐ Neutral	☐ Not really important	☐ Not important at all

Question 7.
What grade would you give to judge the quality of the images?
Pick a number between 1 and 10, with 10 being a maximum quality

Question 8.
Do you think the Telebaby-system adds value to the healthcare system?
Pick one answer

☐ Yes, certainly	☐ Yes, reasonably	☐ Neutral	☐ No, not really	☐ No, not at all

Question 9.
Was het Telebaby-systeem nuttig voor u als ouder?
Pick one answer

☐ Yes, certainly	☐ Yes, reasonably	☐ Neutral	☐ No, not really	☐ No, not at all

Question 10.
Would you recommend the system to others?
Pick one answer

☐ Yes, certainly	☐ Yes, probably	☐ No, probably not	☐ No, certainly not

Did you read the manual?
Pick one answer

O Yes
O No (go to question 13)

Question 12.
Was the manual clear?
Pick one answer

☐	Yes, very clear	☐	Yes, reasonably clear	☐	No, not really clear	☐	No, not clear at all

Question 13.
Did you miss anything in the manual?

Question 14.
To which people did you give your login data?
Multiple answers possible

- O your father or mother
- O your brothers or sisters
- O your mother in law or father in law
- O your best friends
- O your coworkers
- O others:

Question 15.

Statement: I was less worried when I could see my baby.

☐	Very important	☐	Reasonably important	☐	Neutral	☐	Not really important	☐	Not important at all

Question 16.
From where did you use the Telebaby system?
Multiple answers possible

- O From my house
- O From my work
- O From the house of my family
- O From the house of my friends

Question 17.

Statement: I could see if my baby was taken good care of.

☐	Very important	☐	Reasonably important	☐	Neutral	☐	Not really important	☐	Not important at all

Statement: It was difficult to terminate the Telebaby-connection.

☐	Very important	☐	Reasonably important	☐	Neutral	☐	Not really important	☐	Not important at all

Question 18.
Which people do you think have helped in creating the Telebaby-facility?
Multiple answers possible

- O Nurses
- O Doctors
- O IT-specialists
- O Hospitals Management
- O Patients

Question 19.
Do you think that the costs for the Telebaby system (for instance telephone costs) should be paid by the insurance company?
Pick one answer

- O 100%
- O 75%
- O 50%
- O 25%
- O the costs should not be paid by the insurance

Telebaby does not cost you any money. The UMC Utrecht will **never** ask money for Telebaby from parents; we see it as an extra service. Yet we would like to quantify (in money) what the added value from a system like this is for you.

Question 20.
If you were asked to pay for this service, what do you think would be a reasonable amount of money per week and per minute?
Pick your answer per week, and the answer per minute

Per week		Per minute	
O	I would not pay anything	O	I would not pay anything
O	1 - 5 Euro per week	O	Less than 5 cents per minute
O	5 - 10 Euro per week	O	5-10 cents per minute
O	10 - 25 Euro per week	O	10-20 cents per minute
O	More than 25 Euro per week	O	More than 20 cents per minute

Question 21.
What is your baby's name, or names if you have twins?

Question 22.
Has the mother been admitted to the hospital?

O Yes
O No (go to 25)

Question 23.
How long has the mother been admitted?

days

Question 24.
Has the mother used the internal video circuit?
Pick one answer

O Yes
O No

Question 25.
Do you consider yourself an Internet expert?
Pick one answer

☐	Yes, certainly	☐	Yes, reasonably	☐	Neutral	☐	No, not really	☐	No, not at all

Question 26.
Do you think you learned something about the Internet in general after having used the Telebaby system?
Pick one answer

☐	Yes, certainly	☐	Yes, reasonably	☐	Neutral	☐	No, not really	☐	No, not at all

Question 27.
Cross which answer(s) are applicable:
Multiple answers possible

- O I have Internet at home
- O I have email at home
- O I have Internet at work
- O I have email at work

Question 28.
How far do you live from the hospital?
Pick one answer

- O 0 – 25 kilometers
- O 25 – 50 kilometers
- O 50 – 100 kilometers
- O more than 100 kilometers

Question 29.
How old are you?

years

Question 30.
What is your profession?

Question 31.
What is your gender?

- ○ Male
- ○ Female

Question 32.
Do you have any questions? Comments? Suggestions to improve the Telebaby system? Your feedback is highly valued!

Thank you for your cooperation!

Appendix C

Selection of media coverage VBVS in the Netherlands

Date (m-d-y)	Media	Scope media	Title
9-8-2001	Volkskrant	National: written press/Internet	Big Mother
11-28-2001	UMC Utrecht	Hospital: Internal media	Telebaby: ouders volgen hun couveusebaby via internet
12-5-2001	Utrechts Nieuwsblad	National: Internet	Ouders kunnen baby volgen op internet
12-5-2001	AD & Parool	National: written press/Internet	Couveusebaby op internet te volgen
12-5-2001	NRC	National: written press/Internet	Couveusebaby op internet
12-5-2001	Spits	National: written press/Internet	Ouders kunnen baby volgen op internet
12-5-2001	Telegraaf	National: written press/Internet	Couveusebaby voortaan via internet te zien
12-6-2001	RTL-4 Nieuws	National: television	Big Mother
1-2-2002	Nunspeet	Regional: written press	Thuis op internet kijken naar baby in couveuse
2-21-2002	Univers	University	De BIK'er en Telebaby
11-5-2002	UMC Utrecht	Hospital: corperate campaign	Big Mother
11-5-2002	UMC Utrecht	Hospital: presentation	Telebaby: Live videostreaming of Newborns over Internet
4-15-2003	Uitnodiging	National: innovation prize	Programma Uitreiking Vosko Trofee
6-1-2005	De Week	National: written press	Kwetsbare campagne wint
10-1-2005	Kind en ziekenhuis	National: written press	Baby online: verarming of verrijking?
1-17-2007	Catharina-ziekenhuis	Hospital: press-release	Mobiel in Catharina-ziekenhuis
1-17-2007	Vodafone	Mobile provider: press-release	Catharina-ziekenhuis Eindhoven wereldprimeur
1-17-2007	Allesvan.nl	National: Internet	Pasgeboren baby kijken via gsm
1-17-2007	Bogobogo	National: Internet	Baby mobiel in het Catharina
1-17-2007	Health-valley.nl	National: Internet	Baby mobiel in Catharina-ziekenhuis
1-17-2007	Medicalfacts.nl	National: Internet	Waar ook te wereld naar je baby in het ziekenhuis kijken via mobiel
1-17-2007	Nederland breedbandland	National: Internet	Kijken naar je couveusebaby op de mobiel
1-17-2007	Netn.nl	National: Internet	Catharina ziekenhuis wereldprimeur met 'baby mobiel'
1-17-2007	Quickscoop	National: Internet	Baby mobiel: 24 uur per dag je kindje in het ziekenhuis kunnen zien
1-17-2007	Telegraaf.nl	National: Internet	Mobiel kindje kijken
1-17-2007	Dezendervooreindhoven.nl	Regional: Internet	Baby bekijken via mobiele telefoon
1-17-2007	Omroep Brabant	Regional: Internet	Pasgeboren baby kijken via gsm
1-18-2007	Mensenlinq.nl	National: Internet	Couveusebaby via gsm
1-18-2007	Nieuws	National: Internet	Baby mobiel in Catharina-ziekenhuis
1-18-2007	BN de Stem.nl	Regional: Internet	Couveusebaby via gsm
1-18-2007	Eindhovens dagblad	Regional: Internet	Dankzij gsm online met baby
1-18-2007	BN de Stem	Regional: written press	Couveusebaby via gsm
1-18-2007	Eindhovens dagblad	Regional: written press	dankzij gsm online met baby
1-19-2007	Blik op nieuws.nl	National: Internet	Catharina ziekenhuis Eindhoven wereldprimeur met 'baby mobiel'
1-19-2007	Brabants dagblad	Regional: written press/Internet	Dankzij mobiele telefoon online met baby
1-20-2007	AD.nl	National: Internet	Ziekenhuisbaby op mobieltje
1-20-2007	AD	National: written press	Ouders kunnen hun baby in ziekenhuis op mobieltje zien
1-22-2007	Blogo.nl	National: Internet	Beelden baby in ziekenhuis op mobieltje
1-22-2007	Nieuwe producten	National: Internet	Zeg eens papa tegen de babymobiel
1-23-2007	Ikvader.nl	National: Internet	Mobiel meegluren naar de couveusebaby
1-23-2007	Zorgpers	National: Internet	Baby mobiel in Catharina ziekenhuis
1-24-2007	Groot Eindhoven	Regional: written press	Verbonden aan je baby
1-25-2007	Catharina-ziekenhuis	Hospital: internal media	Baby mobile in Catharina hospital
1-25-2007	Babyinfo	National: Internet	Baby mobiel: altijd je baby zien
1-25-2007	ANP pers support	National: press-release	Catharina ziekenhuis Eindhoven wereldprimeur met 'baby mobiel'
1-26-2007	Telegraaf.nl	National: Internet	Mobiel kindje kijken
1-28-2007	Zondagsnieuws	Regional: written press	Baby's in ziekenhuis te zien via 'baby mobiel'
2-9-2007	Elsevier	National: written press	Gerust gevoel
2-10-2007	Elsevier.nl	National: Internet	Gerust gevoel
2-10-2007	Elsevier	National: written press	Couveusebaby in beeld
6-1-2007	High Tech Analysis	National: written press	Telezorg groeit spectaculair
9-24-2007	Mzorg	National: innovation book	Overal contact met je baby
11-1-2007	Telecommagazine	National: written press	Mobiliteit verbetert zorgverlening: toepassing in primaire proces
4-1-2008	Arts en Auto	National: written press	BabyMobiel
30-5-2008	High Tech Analysis	National: written press	Zorg zonder stekker: mobiel heeft groot onontgonnen potentieel
30-6-2008	Vraag in Beeld	National: written press	E-health levert patiënt veel op : onbekend maakt onbemind
4-10-2009	SBS-6	National: television	BabyMobiel
9-7-2011	Universiteit Utrecht	Hospital: press release	Dierenkliniek Utrecht start met ‘Telepet’
9-8-2011	Algemeen Dagblad	National: written press	Huisdier via webcam (technology VBVS in vetinary hospital)
9-8-2011	Telegraaf	National: written press	Blaf eens naar het baasje (technology VBVS in vetinary hospital)
10-23-2011	De Jachthond	National: written press	Telepet (technology VBVS in vetinary hospital)
11-1-2011	Hondenleven	National: written press	Via een webcam je zieke hond volgen (technology in vetinary hospital)

Appendix D

Survey list items market analysis VBVS in the Netherlands

Survey list item #	Survey list item
1.	Hospital name
2.	Hospital place
3.	Hospital homepage
4.	Phone number
5.	Hospital type
6.	Neonatal care type
7.	Virtual Baby Visit
8.	Year started
9.	Number of cameras
10.	Intention to start
11.	Closed Camera Circuit Television
12.	Visiting hours
13.	Visiting hours (text)
14.	Payment
15.	Supplier
16.	Trigger hospital
17.	Name
18.	Contact name
19.	Contact function
20.	Contact e-mail
21.	Contact phone number
22.	Homepage System
23.	Future mobile?
24.	Interested in Mini-symposium
25.	Remarks
26.	Link extra information 1
27.	Link extra information 2
28.	Link extra information 3

Appendix E

Details market analysis VBVS in the Netherlands

Hospital name (undisclosed)	Hospital type	Neonatal care type	Chronology	Classification
	Top-clinical	Post IC-HC	2009	Early Majority
	General	MC	2009	Early Majority
	General	MC	2009	Early Majority
	General	HC-MC-LC	2009	Early Majority
	University	IC-HC-MC	2008	Early Majority
	University	IC-HC-MC	2008	Early Majority
	Top-clinical	IC-HC-MC	2008	Early Majority
	Top-clinical	HC-MC	2008	Early Majority
	General	MC-LC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
	General	MC	2008	Early Majority
”Chasm”	General	MC	2008	Early Majority
	Top-clinical	HC-MC	2007	Early Majority
	General	MC	2007	Early Majority
	General	MC	2007	Early Majority
	University	IC-HC-MC	2006	Early Majority
	Top-clinical	Post IC-HC	2006	Early Majority
	Top-clinical	Post IC-HC	2006	Early Majority
	Top-clinical	MC	2006	Early Majority
	General	MC-LC	2006	Early Majority
	General	MC-LC	2006	Early Majority
	General	MC	2006	Early Majority
	General	MC	2006	Early Majority
	Top-clinical	Post IC-HC	2005	Early Adopter
	Top-clinical	MC-LC	2005	Early Adopter
	General	Post IC-HC	2005	Early Adopter
	General	Post IC-HC	2005	Early Adopter
	General	MC-LC	2005	Early Adopter
	General	MC	2005	Early Adopter
	General	MC	2005	Early Adopter
	General	MC	2005	Early Adopter
	General	HC-MC	2005	Early Adopter
	Top-clinical	IC-HC-MC	2004	Early Adopter
	Top-clinical	HC-MC	2004	Early Adopter
	General	MC-LC	2004	Early Adopter
	General	HC-MC	2004	Early Adopter
	General	HC-MC	2004	Early Adopter
	Top-clinical	IC-HC-MC	2003	Early Adopter
	General	MC-LC	2003	Early Adopter
	General	MC	2003	Early Adopter
”Chasm”	General	HC-MC	2003	Early Adopter
	Top-clinical	Post IC-HC	2001	innovator
	General	MC	2001	innovator
	University	IC-HC-MC	2000	innovator

Appendix F

Interview protocol

1. (general Technical introduction and recorder set up
2. (general) Lead in:

   Can you introduce yourself?

   What is your formal position as IT manager in the organisation?

   Can you describe the structure and functions of the departments under your control?
3. (IT innovativeness)

   What is your opinion, as an IT manager, of the level of the hospital innovativeness?

   What is your opinion, as an IT manager, of the level of innovativeness the hospital in comparison with other hospitals?

   What is your opinion, as an IT manager, of the level of the hospital IT innovativeness?

   What is your opinion, as an IT manager, of the alignment between organisations innovativeness and the IT innovativeness?

   What in your opinion, as an IT manager, are factors of positive contribution towards IT innovativeness? An interview support (see below) is presented to facilitate this question:

   - Can you scale the following value factors on a scale 0-10 interview: Politics, Market, Strategy, Organisation, Process, Technology, Product, Economy, Customer, Human?
   - The highest and lowest ranked items will be addressed more specifically: What is your opinion, as an IT manager, of the (lowest) and (highest) ranking factors (or spontaneous elaboration on factors).
   - (IT resources) What role do IT resources play in IT innovativeness? What is the size of your IT budget as a percentage of your revenue?
   - (IT resources alignment) Can you give an overview of the decision making process and structure around IT innovations?
4. Lead out:

   (personal IT innovativeness) Can you describe what IT innovativeness means to you as a person?
5. (general) round up, feed-back, contact information and possibilities for future research

Interview support

Area	Scale
Politics	not at all 1 2 3 4 5 6 7 8 9 10 very high
Market	not at all 1 2 3 4 5 6 7 8 9 10 very high
Strategy	not at all 1 2 3 4 5 6 7 8 9 10 very high
Organisation	not at all 1 2 3 4 5 6 7 8 9 10 very high
Process	not at all 1 2 3 4 5 6 7 8 9 10 very high
Technology	not at all 1 2 3 4 5 6 7 8 9 10 very high
Product	not at all 1 2 3 4 5 6 7 8 9 10 very high
Economics	not at all 1 2 3 4 5 6 7 8 9 10 very high
Customer	not at all 1 2 3 4 5 6 7 8 9 10 very high
Human	not at all 1 2 3 4 5 6 7 8 9 10 very high

Code list variables

Process variables

Category	Name	Values
P1	Transcript status	Transcript send Transcript confirmed
P2	Date	Date and time interview
P3	Duration	Number of minutes interview
P4	Words	Number of words transcript
P5	Words per minute	Number of words transcribed per minute interview

Variables on a personal level

Category	Subject	Number identification Subject
S	Subject number	
S1	Name	First and last name interviewee
S2	Phone	Phone number interviewee
S3	E-mail	E-mail address interviewee
S4	Age	Age interviewee below 45 or 45 plus
S5	Gender	Gender interviewee male or female
S6	Position	Position interviewee interim or fixed
S7	Training	Formal training interviewee, medical or non-medical
S8	Scope function	Scope of function interviewee IT or IT plus, derived from interview
S9	Perceived personal IT innovativeness	Low or high, derived from interview

Variables on organisational level

Category	Hospital	Name and place main residence hospital
O1	Revenue size	Hospital Revenue size 2007 in million of Euro's, annual Report 2007
O2	Number of FTE	Hospital number of full time equivalent (FTE) workforce annual Report 2007
O3	IT Budget size	Hospital IT budget size in million of Euro's 2007, calculated from O2*O6
O4	IT Budget per FTE (result O4/O3)	Hospital IT budget IT Budget per FTE in Euro's 2007, calculated from O4/O3
O5	IT Budget % of revenue	Hospital IT Budget as % of revenue, derived from interview
O6	Hospital type	University or top-clinical, derived from interview
O7	Financial IT resources	Low or high, derived from interview
O8	Perceived IT alignment	Low or high, derived from interview
O8A	IT governance structure	Decentralized or centralized, derived form interview
O8B	IT policy board orientation	Care or resource, derived form interview
O9	Perceived organisation IT innovativeness	Low or high, derived from interview
O10	Perceived personal IT innovativeness	Low or high, derived from interview
O11	IT innovativeness VBVS	Classification adoption based on year of implementation VVS

Population

IT innovativeness VBVS	Hospital type	Hospital name (undisclosed)
1. Innovator	University	
2. Early Adopter	Top-clinical	
2. Early Adopter	Top-clinical	
3. Early Majority	University	
3. Early Majority	University	
3. Early Majority	University	
3. Early Majority	Top-clinical	
4. Late Majority/Laggard	University	
4. Late Majority/Laggard	University	
4. Late Majority/Laggard	University	
4. Late Majority/Laggard	University	
4. Late Majority/Laggard	Top-clinical	
4. Late Majority/Laggard	Top-clinical	
4. Late Majority/Laggard	Top-clinical	
4. Late Majority/Laggard	Top-clinical	
4. Late Majority/Laggard	Top-clinical	

Appendix G

Highlights results per subject

Sub-ject	Type	IT Budget % of revenue	Resources available for IT	Financial resources technology innovation (AFR)	Percieved IT alignment (PITA)	Percieved IT innovativeness (PI)	Percieved Personal IT innovativeness (PPI)
1	2. Early Adopter	3,1%	High =>3%	High	High	High	Low
2	4. Late Majority/Laggard	5,5%	High =>3%	Low	High	Low	Low
3	4. Late Majority/Laggard	3,1%	High =>3%	High	Low	Low	High
4	4. Late Majority/Laggard	3,3%	High =>3%	High	High	High	High
5	4. Late Majority/Laggard	2,5%	Low < 3%	High	Low	Low	Low
6	4. Late Majority/Laggard	1,6%	Low < 3%	Low	Low	Low	Low
7	4. Late Majority/Laggard	3,1%	High =>3%	High	Low	Low	High
8	2. Early Adopter	3,0%	Low <= 3%	Low	High	Low	High
9	1. Innovator	4,0%	High =>3%	High	Low	High	High
10	4. Late Majority/Laggard	5,0%	High =>3%	High	High	High	High
11	3. Early Majority	4,5%	High =>3%	High	Low	Low	High
12	4. Late Majority/Laggard	3,0%	High =>3%	High	High	High	High
13	3. Early Majority	3,0%	High =>3%	High	Low	Low	High
14	4. Late Majority/Laggard	3,0%	High =>3%	High	Low	Low	High
15	3. Early Majority	3,5%	High =>3%	High	High	Low	High
16	3. Early Majority	4,0%	High =>3%	Low	High	Low	High

Highlights from subjects narrative

#	S	AFR	Narrative
1	1	High	No, in that respect, I don't feel restricted to do things yet.
2	2	Low	With the limited group of people I have, those who are there at least, within my department and within the operational ICT, then we are pleased with the projects we were able to finish.
3	3	High	And that's because we don't have the budget, but that's not really the problem, because to date, I have actually received each budget I requested.
4	4	High	Obviously, they do play a role, but in fact they hardly play any role. Always finished my overall project within the budget. While, in a year, the things I did were completely different than what I'd previously planned to do.
5	5	High	If you want something, you can always find the money for it. Although it can be difficult with the widespread introduction of innovations. But in such cases, the motivation is so high that it happens anyway. In my experience, it's always possible to find the necessary resources. Unless the business case does a 180.
6	6	Low	We have a limit for all investments of 7-8 million. The innovations and the conservations have to be realised within this limit. The investment funds partially come from the funds that are released for replacement investments.
7	7	High	Not yet, I'll tell you why. Because the basis of the innovation which we currently do is almost a commodity, it's still possible to realise that with relatively little expertise. (...) That is currently not at issue at all. (...) Perhaps, this also has to do with the necessity of what we are doing. Not with a strategic consideration, whether yes or no, it has to be done, so we'd better do it.
8	8	Low	Of course, there is a budget, and that should be sufficient. And if I have an important project in my capacity of cluster manager, there are basically two possibilities. He can apply for an investment, or he can start paying out of the collective funds, and then it is limited.
9	9	High	This is not a limitation. . There are no financial problems. I actually don’t have any restrictions as information technologist. No bottleneck in terms of money, so far. I find *** an example of an organisation which can do a lot with IT, because there is a budget. Hence, the strength of the organisation goes hand-in-hand with the money.
10	10	High	Then I receive it. If I don't receive it, let's say I receive minus 20 per cent of what I ask; I go back to the policy board. Then I say, we asked for this, but receive that, so we face a challenge. (...) It hasn't happened yet so far, but it has to do with the fact that if you don't invest in innovation for 5 to 10 years, then you are about to drown.
11	11	High	What I did was create an enormous goodwill in concerning this product, so I have worked very hard to obtain a wide support; I have received five letters from several groups in the hospital, who all claim: this is absolutely necessary. (...) It will happen, the only thing they asked this morning was: are we're going to control this by policy? (...) But I'm 80-90 percent sure it will get through.
12	12	High	We actually managed to pull it off relatively easily, despite the current difficult macro-economic situation. So in any case, this means that within this organisation, there is great awareness of the fact that the only way out of the misery consists of a flight forward, by means of innovation and the deployment of new resources.
13	13	High	No, and that isn’t really an obstacle.
14	14	High	It's 10, 15 or 20; I’ve previously said 10 per cent, and at that time, I believe we had a projects budget of about 40 million. So, that was €400,000,-. What did we do with it? We started with teleconferencing, in order to introduce it here on a wide-ranging basis. That was something the organisations didn't want to spend any money on. And the management board told us to now go and write a business case. But we thought, it's just too important. In fact, we misused this budget for introducing our hobbies of IT into the organisation.
15	15	High	Money always plays a role. But honestly, it doesn’t play a role, because the bottleneck lies elsewhere. I suppose, and in the past I have also demonstrated, that money is never a problem in IT, and in my opinion, this is no different in the healthcare sector. Often, we don't know what we're doing and then we waste money because projects are not started in an efficient way. Projects then become too long, too complicated and too expensive. If everything is well organised, money is never a problem in IT. I think it's strange, everyone always claims that money is a problem in IT, but I don't believe that.
16	16	Low	I think that money has been an obstacle. I haven't work here long enough to be able to experience that myself. (...) Because it was used as an excuse to not innovate. Like: yes, we think it doesn't fit in view of the whole, we do not understand it. They requested 50 million, but we really don't know for what exactly, and what we will we receive in return. However, it may well be that it ultimately still plays a role. Let me put it this way: yes, I do think that there is a critical barrier for investment readiness.

#	S	PITA	Narrative
17	1	High	In the ***, the *** department, we have an IT steering committee. The IT steering committee is composed of three medical specialists, a head of department from the health services, now called a centre manager, and the financial controller and the head of IT, and the former information controller, and the president is***. The steering committee assesses each incoming request. We, as IT, firstly do an intake.
18	2	High	All the projects are discussed within a body, created to this end, namely the advisory group Information Policy, on the basis of a dozen criteria. This group consists of 14-15 persons, physicians, one is the president, and myself and my information architect from my department, that is ***, the manager and these three head of departments. They are: a medical clinical physicist, one of the care managers, one of the doctors is also a medical microbiologist, and a manager Facility Management. And additionally, another head of a subordinated care unit. It's a pretty good reflection of the hospital management layer.
19	3	Low	This is the formal process, project application, review by a direction committee, in order to verify whether the form is complete, and ultimately decision making by the Management Team ***. (...) It consists of representatives of the clubs that manage the capital assets and services. So I'm a part of that; it includes the head of accommodation, construction, the manager who deals with the investments. (...) And also a care services managers Hence, he has to implement the care services. (Interviewer) The care services manager, is that a doctor? No, that's a person from our organisation.
20	4	High	The directorate IT is one of the major directorates. Besides that, IT contains four groups, decentralised IT groups in division one to four. (...) What we currently do in the context of the IT Directorate, is to conduct consultations every two months with all the IT contacts in the relevant departments, in order to check which progress they make. Which new ideas they have.
21	5	Low	Direction and Management Board. Smaller innovations are started under the responsibility of the respective sub-director (responsible for the matters to be innovated). Large-scale, substantial innovations, such as setting up new care centres or a whole new organisation, are submitted to the Management Board. (...) Obviously, you have a strategy. They lay down the lines along which you want the organisation to develop. (...) Usually, the requested innovation is presented and subsequently submitted to the Management Board. There is an investment committee. The investment committee then assesses the request. (...) (Interviewer) Who are the members of this investment committee? A delegate of the general staff and the direction.
22	6	Low	In this hospital, we have set up a direction committee. (...) Additionally, there is a whole list of activities. Although they are submitted to the direction committee for informational purposes, they actually fall under the responsibility of the director operations management. And the director operations management aligns the envisaged operations with the respective groups, the *** but not the care service groups, because they are represented in the direction committee.
23	7	Low	Within the organisation, we prepare business cases for the innovations and modifications to be undertaken together. These cases are approved or rejected or assessed by the Management board; if the Management Board approves, you have the budget to realise the envisaged innovations or modifications. And if you're smart, you make sure you have a sound business case, with a number of resources, which you might have to get out.
24	8	High	We organised it in such a way, as to have a steering committee, which is the committee patient care systems, which is also the steering committee of the new HIS SPD. And in principle, this committee decides whether large projects or projects that have a large IT component will be launched or not. I'm the president of this committee. The members of this committee consist of some doctors, a member of the medical staff board, a cluster manager and the purchaser. So, it actually represents a major intersection of the hospital. Three cluster managers, and also the clinical medical physicist takes part.
25	9	Low	We are at a stage where the IT organisation is supposed to create the support for the things we do, and to initiate them. . Hence, we don't have a hospital-wide governance board that deals with prioritisation and the various choices to be made. So, it's not the case that the requesting party is active and takes the initiative. However, such is the case when it comes to substantive choices. For the most important programs we formed hospital-wide steering committees. They determine the content and the pace of the program, and the functionalities.
26	10	High	We have three layers, three consultation bodies; at the highest level, we have an IT steering committee, whose members are: the portfolio holder IT Management board, all the medical directors of the various business units, and myself. And really, this committee does nothing more than monitoring and supervising whether the governance model we invented continues to function in a satisfactory way. (...) Hereunder, you have the director operations management, in the policy board. And this policy board deals with a number of matters; policy-making, preparation of an appropriate annual plan.
27	11	Low	The IT governance of this organisation is not well-organised. (...) There are huge IT investments involved… the annual financial statements, prepared by the accountant, show that the IT governance is not well- organised. The decisions … are not executed in an evenly balanced way.
28	12	High	To this end, we have set up the domain committee. So that doctors don't have to discuss the assessment and achievement of business objectives with technologists. But that he instead explains to his own peers within the domain committee patient care how it fits into the big picture. So that, by means of peer review, a real distinction can be made between some local issues, that are important to doctors, and issues of general importance.
29	13	Low	We have a club of consultants, who can brainstorm with us. This results in a quick scan, which is then reviewed

			by the head of IT, by me and by the management board. Subsequently, it’s approved or disapproved. And then, it will be implemented.
30	14	Low	The IT committee contains three existing consultative bodies. They consist of the directors' consultation, the corporate systems, the board of directors, like me, financial, logistics, HRM, R&D, that kind of people. Patient care is also included. Additionally, we have an I&T platform, which includes about five cluster agency managers, who provide advice. It also includes a care services manager, who assesses the primary process. The management board directs the medical heads of department. And some of those heads of medical department form part of a cluster. And within a cluster, there is a care services manager, who, in fact, is responsible for the whole nursing part. And the medical heads of department direct the doctors. Then, I have a problem, because in which way is the manager care services directed?
31	15	High	We created a body, with the name: IT priority board, in which the representatives of all the instructing parties in the organisation participate. We have eight people. We hold a meeting once a week. And we have from the very beginning, which is actually from December (...) Basically, we only started to work at full steam in February this year. In January, we were shaping the priority IT board, and now it functions properly.
32	16	High	Due to the previous way of working, IT was very decentralised. (...) It was decentralised, unless in cases of a central decision. (...) In this decentralised situation, ambitions came forward (or not) from within the primary process, for instance, from a surgery department or an obstetric department. At such moments, departments may have communicated their requirements to the ICT club. But such requirements could just as well be communicated externally. . So innovation only took place on the own initiative, but also had to be financed with own resources of the primary process, or with a third money flow, which was accidentally tapped into. There was no hospital-wide direction. This is still the case, and we are now going to change that.

#	S	PI	Narrative
33	1	High	If you look at the IT sec, I think we are pretty innovative. (...) As for me, I'm a bit more modest, I would nevertheless give us a 7 to 7.5.
34	2	Low	When I look at where we stand and where we are supposed to be, I find it rather depressing. Because I find that the introduction of things, which in fact, should be standard facilities, is very time-consuming (...) This has nothing to do with innovation; it concerns products and processes that have been around for years. There is no room for real innovation, because you're simply behind with things you already wanted to have.
35	3	Low	It is insufficient; there are others who are more advanced in regard to some parts. (...) And we have also many facilities across-the-board, which are all low-profile facilities and not very innovative either. But which are very important for a hospital and have become indispensable.
36	4	High	Then I think, we score an eight if I compare our situation with the general hospitals that I have seen, and those are usually the larger hospitals. (...) When looking at colleagues, I think that, generally spoken, we are pretty average or slightly above the average, in terms of innovation.
37	5	Low	Between 6 and 7. It has to do with a kind of leading position we wanted to take, and where we have made choices that eventually turned against us. Similar to the law of the handicap of a head start.
38	6	Low	Within IT, we are actually a department (...) that comes from a very non-progressive and conservative environment. So there was little innovation in IT. I would like to qualify it as a 5. Not even as a trend-follower.
39	7	Low	Then, I will give a very conservative "pass": 5.8. Two things, IT does not consider in which way things can be improved in order to work in a more efficient and effective way. In fact, IT is steered on the basis of events. Event-driven, something emerges and we'll pick it up. And the second point is that we're so busy with operations, things and little chores, that there can't be any question of innovation, there isn't even sufficient time and quiet to look ahead. It’s innovative, but not driven by any form of market knowledge, business knowledge, just to name an example.
40	8	Low	Personally, I'm quite ambitious in that respect, just not enough for a "pass". But, again if you put that table next to that of my colleagues in hospitals, I stand out negatively, and thus, I probably don't do justice to the department. But I have the feeling we could do more.
41	9	High	When you say that innovation consist of offering new functionalities, functional extension of the IT park; this dominates our agenda at the moment. I think the next phase will consist of functional improvements. Providing new functionality (...) What are you doing, we are modernising a large amount of things (...) Replacing, modernising and expanding.
42	10	High	When I look at innovation, it particularly concerns the major projects, such as the projects we are currently running under ***.
43	11	Low	And what we do is leave things as they are. (...) The organisation is innovative in its way of thinking, but not in its implementation. And that's the big problem, we are very good at analysing, but not at implementing and ensuring that subsequently everybody will follow suit.
44	12	High	The IT organisation has even initiated the alignment, because the business had not yet decided where it wanted to go. So organising this process is exactly what we have done over the past two years.
45	13	Low	It's just what you call it. If you cut and paste external technology, then you're innovating compared to others. That's a relative innovation, but do you really innovate? (...) We run faster than the company. But in your IT department, there always is a tension between managing and innovating. Management is necessary, and that's the way it works. If it fails, you will be judged on your management. If the whole server park crashes, you have a problem.
46	14	Low	We have an IT plan (…) and in that plan we said somewhere that 10 per cent of the IT turnover should be spent on innovation. As a minimum. Trying to substantiate that with IT projects.
47	15	Low	What I see is that hospitals, the entire healthcare sector really, suffers from the law of the handicap of a head start. A few years ago, maybe 10-15 years ago, in my view, the healthcare sector was ahead of the rest of the world.
48	16	Low	What I've encountered so far, are situations where I think we're not even able to think of the word innovation.

#	S	PPI	Narrative
49	1	High	I think I'm supportive in a positive way and perhaps a little pushing.
50	2	Low	Of course, partially, you try to enthuse people for certain things. On the other hand, you're also stimulated yourself by people who put forward interesting things. But subsequently, you have to be pragmatic with the resources available. People can have the most beautiful or nice ideas, but if you say: does it make sense? (...) Trying to improve, to innovate and to change**.** But always within the existing possibilities.
51	3	Low	No, not specially, I'm not a person that always buys the latest gadgets. (...) No, I try to put it forward, and I do put it forward. Above all, I put my energy in continuity. Availability and short lead time of projects. And certainly not starting projects with unclear outcomes.
52	4	High	I mainly focus on process innovation. I especially try to look beyond the boundaries of individual disciplines and stimulate the people. Due to the way we are organised, all employees are compartmentalised in different departments, which creates a strong tendency to sub-optimise the activities within the departments, and I try to build bridges between the departments within the division, mainly via the heads I&A and the divisions, the processes that are implemented throughout the whole organisation.
53	5	High	Nice! Nice to see innovation, it's nice to see new processes emerging, to gain new experiences, to discover things. That is something that really appeals to me. The creativity, which you encounter in innovation. Making new things possible. Which also leads to the improvement of the healthcare, and sometimes, that can be extremely gratifying.
54	6	Low	Innovation is a must, but only if it adds value to your process. For stability, continuity and availability, you better make a choice and implement that choice when it comes to technology and products, and then assess from there what will be your next innovation. But certainly not just jump to new things each time.
55	7	Low	I'm not a frontrunner in contriving new things, in the sense that I try to find a balance between the novelties you can contrive and how much you're able to manage. I can contrive a lot, but if I'm not able to manage it, it will go wrong. I'm kind of allergic to some projects that start with big objectives, to be subsequently forgotten, and that afterwards have to be picked up and managed by somebody else.
56	8	High	I'm a pragmatic person. That's one point. Then you could say, you are not innovative. (...) By nature, I'm someone who is really looking for creative solutions. And often the solution doesn't lie in the technology, especially not in technology, but in everything that surrounds it. I embrace innovation, but you shouldn't innovate for the sake of innovation. It should be accompanied by a clear picture.
57	9	High	As a person? Like most people, I go for change. I love to realise improvement and innovation. Everybody gets a kick out of that, and so do I.
58	10	High	I think that innovation is not something that should be initiated by the technique and the technology, but rather by the operations management and the things you want to achieve in the context of that operations management. Hence, innovation is 90 percent process innovation.
59	11	High	I strongly believe that you have to build and assemble the systems yourself, since there is no HIS supplier who is able to do that, they all have their strengths and weaknesses. We are convinced that when you use the RIM model, and if the industry would do so as well, you will no longer have preferred suppliers. If you meet the standard, you will be able to randomly pick modules, and then it will work.
60	12	High	Well, innovation is also my personal hobby, since the mid 90's, actually a little earlier, via TQM, Continues Improvement, I was involved in the research in regard with solutions which, on one hand, keep the business running and, on the other hand, are able to meanwhile implement the necessary innovation. Despite the conflicting requirements it imposes on the resources. So, from an intellectual point of view, I consider myself to be very innovative.
61	13	High	And respond to him by changing. Everyone around me is affected by my changed behaviour. Once it's running, it's no longer fun for me. Then I turn my back to it. Then I'm not involved any more. So, I always make sure that there are people around me who take over the management function, who accept do that. I take in, new ideas for what somebody wants, I like that.
62	14	High	I've always been a bit of a "gadgetty" person. For instance, I gave all my sector managers a nice Webcam. That's the way I start and try to get other people behind me. Those smartphones, I started with it, and I gave one to a few of my colleagues, and I gave one to my portfolio holder and then you get the situation that all the members of the (...) carry one with them. This way, you create something.
63	15	High	Over the past eight months, I believe I learnt more than the last 18 years of my life. For me personally, that's incredibly innovative.
64	16	High	I believe I'm really like that. I think that, in any case, I'm very involved with the new concepts that play a role in the world of IT. And I heavily propagandise it. I challenge people to do the same. To go along with and get engrossed in new concepts. Yes, a certain personal preference plays a part. But only from a certain business point of view, it's not a preference in terms of religion. So I hope that it will seep through to my people. At least, I give them the necessary space.

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FINAL WORD

The past 10 years of my life were dedicated to stimulate the adoption and diffusion of an Internet based facility providing a live video stream that connects parents to their hospitalised new-born. These days parents can virtually visit their new-born in more than the half of the Dutch hospitals. I requires little imagination what a support such a system provides.

Implementing and researching an IT innovation in healthcare is complex and it requires support from a group of persons that can easily fill an Airbus A380.

The support of my parents, family, friends, colleague researchers, physicians, nurses, IT staff and industry, embarking on my academic journey, has been crucial during departure, en route and arrival. Our departure was uneventful, however, en route we experienced technical issues for which we found a work-around, and we had to deviate from our planned course due to meteorological circumstances. Finally, after a go around, our crosswind landing was sufficient (since we walked away form it) and we arrived at our destination (albeit) with a slight delay.

From the flight deck; I thank you for your patience and trust. I hope you all enjoyed the flight; and on behalf of our crew; air traffic control Piet, co-pilot Anne, on board mechanic Sander, and cabin crew Arla and Linda I would like to thank you for flying with us and we hope to see you on board in the future.

This work is dedicated to Bailey Ray Hofmeester (4-6-2000/1-4-2007), who was my beacon in Saint-Sauvy, France, where this thesis was completed.